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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

MEETING AT BERNE, 1880.

Published by Authority of the Meteorological Council.

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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

ROME, 1879.

First Meeting of the International Meteorological Committee.

The Meeting was held at the Ministry of Agriculture at Rome, on Tuesday, April 22, 1879, at 1h. 15m. p.m.

Present: MM. Cantoni, Capello, Hann, Mascart, Mohn, Neumayer, Scott, and Wild.

The Resolution of the Congress constituting the Committee was read, and the members proceeded to the election of a President and Secretary, in accordance with Article X. of the Byelaws for the Congress at Rome.

M. Wild was elected President.
Mr. Scott „ Secretary.

It was resolved that all communications made to the Committee should be addressed to the Secretary.

The Secretary was requested to deposit the original Protocols of the Meetings of the Permanent Committee of the Vienna Congress in the Meteorological Office in London.

H. Wild.

9th August 1880.

BERNE, 1880.

Protocol of the First Meeting of the International Meteorological Committee, the 9th August 1880, at Berne.

Present: M. Wild, President. MM. Buys Ballot, Cantoni, Capello, Hann, Mascart, Mohn, Neumayer, and Mr. Scott, Secretary.

The Meeting was opened at the "Observatoire Tellurique," Berne, at 10h. 15m. a.m.

The President welcomed the members of the Committee, and expressed the hope that the deliberations which were to take place on this occasion would produce results useful for the progress of science.

Upon the proposal of the President it was agreed that the Committee might invite those Meteorologists who were present at Berne, and who had made communications to the Committee on certain points of the Programme, &c., to take part in the discussion on their communications, but that in each particular case the Committee should pass a resolution as to the person to be invited.

It was agreed that the official language to be used by the Committee for the protocols, &c. should be French, but that everything should be translated and published in German and English as well, and that the members of the Committee might speak in another language if they wished to do so.

The protocol of the first meeting of the Committee at Rome, on the 22nd April 1879, was read and confirmed.

The Report of the Secretary was read and adopted. (Appendix I., p. 12.)

The President proposed a programme of the questions to be discussed at the Meetings, and at the same time he requested the members to bring forward any proposals which they wished to communicate to the Committee. This programme was adopted (Appendix II., p. 26).

Article VII. of the Programme (the International Meteorological Dictionary) was first discussed.

The following Resolution of the Roman Congress was read:—

"The Congress is of opinion that it would be very useful that an international dictionary of meteorology should be published."

The Committee not having received sufficient information upon this scheme, the question was postponed.

Article III. of the Programme (the Conference on Agricultural and Forest Meteorology convened from the 6th of September 1880 at Vienna) was next taken up.

The following Resolution of the Roman Congress was read:—

"In order to contribute to the progress of agricultural and

forest meteorology the Congress recommends as a programme for study :

"1°. The influence of the meteorological elements upon vegetation.

"2°. The inverse influence of vegetation upon the meteorological elements.

"3°. Agricultural warnings.

"The Congress, finding the subject too important to take a detailed resolution at this meeting, proposes to charge the International Committee with the convening of a special International Conference before next spring, to take into consideration the development of agricultural and forest meteorology."

The Secretary announced that the invitations and programmes for the Conference had been sent to 26 Meteorological Institutes (Appendix Ie., p. 25). The countries which had hitherto announced their intention of sending delegates were :—

Bavaria	-	M. Ebermayer.
Belgium	-	M. Chevron.
France	-	MM. Mascart and Grandeau.
Hungary	-	Baron Friesenhof and M. Schenzl.
Switzerland	-	M. Billwiller.

In addition it was announced as probable that Italy would send M. Tacchini, and that Denmark would send Captain Hoffmeyer.

M. Neumayer submitted the Report and the Protocols of a private Conference of the heads of the Central Institutes of Germany which had been held at Hamburg from the 2nd to the 4th of April 1880, for the discussion of the questions of the Agricultural Programme.

He announced that probably five or six representatives of Germany would go to Vienna.

Mr. Scott informed the Committee that the Meteorological Society of England had nominated a Committee to draw up replies to the questions of the Programme. These replies had been sent directly to Dr. Lorenz von Liburnau at Vienna.

The Committee requested its Secretary to inform Dr. Lorenz of the result of its discussion upon this article of the programme of Rome.

Article IV. of the Programme (the proposed international comparison of Standard Instruments) was then discussed.

The following Resolution of the Roman Congress was read :—

"The Congress recommends the directors of all central institutions to have their instruments compared with the standard instruments of other countries."

The Secretary read the replies which he had received to the Circular (Appendix Ia., p. 13), the result of which was that 20 observatories had signified their acceptance of the proposal.

The opinions of the Committee were divided as to the possibility of carrying out at present a satisfactory comparison of Anemometers. It was decided that the number of acceptances was not sufficient to guarantee the realisation of the scheme as it had been formulated in the Circular.

It was resolved that the question of having standard barometers compared should be referred to a sub-committee composed of MM. Mascart and Mohn.

M. Mascart laid upon the table Vols. 3 and 4 of the "Annales du Bureau Central Météorologique," which had just been published in Paris.

The meeting closed at a quarter-past 12 o'clock.

H. Wild.

Protocol of the Second Meeting, Monday, 9th August, at 5h. 10m. p.m.

All the members of the Committee were present, except M. de Brito-Capello.

The protocol of the first meeting was read and confirmed.

Article XIII. of the Programme (the proposed change of time of the Simultaneous Observation made at the request of the Chief Signal Office, Washington) was discussed.

The President, M. Mascart, and Mr. Scott communicated to the Committee a request which had been made by General Myer to them, as well as to the different Directors of the Meteorological Services in Europe, to change the hour of the simultaneous observation from 0h. 43m. to 0h. 8m. Greenwich mean time. M. Rubenson had addressed a letter, dated 6th June, to the President upon the same subject.

The Committee examined the question of the proposed change, and expressed its opinion that, notwithstanding the inconvenience which might be felt by some observers, General Myer's proposal should be adopted.

The meeting closed at 7h. 15m. p.m.

H. Wild.

Protocol of Third Meeting, Tuesday, 10th August, at 10h. 20m. a.m.

All the members of the Committee were present, and also M. Weyprecht, by invitation of the Committee.

The protocol of the second meeting was read and confirmed.

M. de Brito-Capello assured the Committee that he entirely approved of the resolution taken at last meeting on the question of the simultaneous observation.

Article II. of the Programme (the Polar Conference held in the month of October 1879 at Hamburg, to consider M. Weyprecht's proposal) was discussed.

M. Neumayer, President of the International Polar Committee, read the report of that Committee. (Appendix III., p. 27.)

M. Capello submitted to the Committee copies of the magnetical and meteorological results of the Portuguese expedition to Central

Africa. At the same time he expressed his regret that at present Portugal could not promise to take part in the scheme of the Polar Committee.

After having discussed the proposals of the Polar Committee, the International Meteorological Committee adopted the following Resolution :—

"The Committee has heard the report of the International Polar Committee, and expresses its thanks for this important communication. At the same time it assures the Committee of its support so far as it may be able to render it assistance."

Article XII. of the Programme (M. Köppen's proposal as to the publication of data for rainfall, &c.) was next taken up.

M. Köppen's letter of the 23rd July was read. (Appendix IV., p. 35).

M. Hann informed the Committee that M. Köppen's proposal would soon appear in the *Zeitschrift der oesterreichischen meteorologischen Gesellschaft,* and that he was ready to send to the Committee a sufficient number of copies of this communication, with a resumé in French of the principal points.

The Committee accepted this proposal of M. Hann, and requested the Secretary to distribute the copies of M. Köppen's letter to the principal Meteorological Institutes for the purpose of obtaining opinions upon the proposed change before the next Conference.

The meeting closed at 15 minutes past noon.

H. Wild.

Protocol of the Fourth Meeting, Tuesday, 10th August, 3h. 5m. p.m.

All the Members of the Committee were present ; also Captain Hoffmeyer, by invitation of the Committee.

The protocol of the third meeting was read and confirmed.

The discussion of Article IX. of the Programme (a proposal made by Captain Hoffmeyer respecting an international telegraphic service for the North Atlantic) was commenced. Captain Hoffmeyer's letter of May 11 (Appendix V., p. 37) was read.

After some discusssion the Committee adopted the following Resolution :—

"The Committee without examining the practical details of the question, fully agrees with Captain Hoffmeyer, that the establishment of telegraphic communication with the Färoe Isles and Iceland, with Greenland and with the Azores would be of the highest importance for the progress of the science of weather-forecasting in Europe, and expresses its hopes for the realization of the scheme."

The discussion of Article XI. of the Programme (a proposal by Captain Hoffmeyer respecting the publication of means and

extremes of the meteorological elements for international and telegraphic stations) was then taken up.

Captain Hoffmeyer's letter of the 22nd May (Appendix VI., p. 37) was read.

After some discussion the Committee adopted the following Resolution :—

"The Committee has heard with interest Captain Hoffmeyer's communication, and recommends the Central Institutions to calculate the averages, &c. which he proposes, for the international and telegraphic stations."

Captain HOFFMEYER stated that his Synoptic Charts would be discontinued after those for the month of November 1876 had appeared.

The PRESIDENT expressed, in the name of the Committee, deep regret that these interesting and very useful charts of Captain Hoffmeyer's would cease to appear.

Captain HOFFMEYER hoped that other nations would publish their observations for the Atlantic Ocean as nearly as may be in the same way as M. Neumayer does in his Monthly Summary.

M. NEUMAYER wished, in connexion with Captain Hoffmeyer's statement, to make the following remarks with reference to the proposal which he, conjointly with that gentleman, had made to the Congress at Rome, to the effect that the synoptic charts should be continued and accompanied by a printed text to be issued by both gentlemen under the title of a "Synoptic Weather Review." The proposal had not met with the desired support on the part of the Congress, and on that account had not been carried out by the Deutsche Seewarte or the Danish Institute.

On the other hand daily synoptic charts from the North Atlantic Ocean were prepared from the material collected at the Deutsche Seewarte, and a few specimens were exhibited of these charts, completed by means of the observations from northern stations and the daily charts for Europe and America (and any other available materials).

The charts were drawn not only for 8 a.m. but also for 8 p.m. when necessary, and the Seewarte proposed to publish the results of these investigations in papers to appear in the serial (Aus dem Archiv der Deutschen Seewarte).

Dr. NEUMAYER proceeded to say that the tables of nautical observations from German ships which had hitherto appeared in the "Monatliche Uebersicht der Witterung" would be discontinued unless some reciprocity was shown by other institutes in regard to them. Inasmuch as none of the offices which are in a position to issue such tables have followed the example, it appeared that these tables were not generally considered of great importance, and for that reason the Deutsche Seewarte contemplated the discontinuance of their publication.

Article X. of the Programme (a proposal relative to the exchange of meteorological publications through the post) was next discussed.

The PRESIDENT drew the attention of the Committee to the great expense and uncertainty, and to the delay caused by the transmission of books, &c. through booksellers, and the Committee considered that it would be better to have recourse to transmission by post as far as possible.

Article XIV. of the Programme (a proposal made by M. Renou for the daily interchange of observations made at various stations) was then taken up.

M. MASCART informed the Committee that M. Renou regularly made chromograph copies of his hourly observations, and he asked whether it would not be possible to make an exchange of such communications between the principal observatories of Europe. This scheme appeared difficult of realization, because it would require a daily tabulation of the self-recording instruments.

The Sub-Committee named at the first meeting (p. 4) to examine Article IV. reported that, after having considered the subject of the international comparison of barometers which had been referred to it, it did not at present see the possibility of effecting this comparison, as had been proposed.

For the general comparison M. HANN thought that in the meantime a mutual comparison of the normal instruments of neighbouring countries might be substituted.

This proposal was adopted.

The meeting closed at 5h. 30m. p.m.

H. WILD

Protocol of the Fifth Meeting, Wednesday 11th August, at 9h. 40m. a.m.

All the members of the Committee were present; also M. Hellman, by invitation of the Committee.

The protocol of the fourth meeting was read and confirmed.

Article V. of the Programme (the proposed general catalogue of the meteorological observations and of the meteorological works and memoirs of all countries) was discussed.

The following Resolution of the Roman Congress was read:—

"The Congress states with pleasure that very valuable preliminary work in the way of catalogues of meteorological observations, memoirs, and works has been already partly executed. But as it is to be desired that these materials should be collected in a general catalogue, the Congress proposes that these publications be divided into two categories:—

"1°. A catalogue of series of observations.

"2°. A catalogue of meteorological works and memoirs.

"As to the first category, the Directors of the different Meteorological systems are invited to prepare catalogues of the published and unpublished observations in their respective countries, and to

inform the International Committee of the work already done in that direction.

"As to the second category, the Congress is of opinion that the works already done by Professor Cleveland Abbe, and the catalogues already printed of the library of the Meteorological Society of London and of that of the Observatory of Brussels, might well serve as a starting point for more comprehensive publications, and invites all the directors of other meteorological libraries to add the list of works and memoirs which are not yet entered in these catalogues."

M. HELLMANN communicated to the Committee a resumé of his ideas on the scheme for a Catalogue. (Appendix VII., p. 38).

Letters to the Secretary from Mr. Symons, dated 15th July, and from Mr. Ramsay, dated 20th July, were read.

On the proposal of the PRESIDENT, the discussion of the question was divided into two parts:

A. Catalogue of books and articles.

B. Catalogue of observations.

A. *Catalogue of Books.*

M. MASCART announced that the Société Météorologique of France had received a library which was very rich in works on Meteorology, and that it was to be hoped that a general catalogue of French memoirs would be prepared.

Mr. SCOTT announced that he hoped that the Meteorological Council would be disposed to assist in the scheme so far as relates to the Catalogue for the English language.

M. MOHN announced that he was ready to do the same for Norway.

M. HANN announced that he was ready to do the same for Austro-Hungary.

M. BUYS BALLOT announced that he was ready to do the same for Holland.

M. NEUMAYER announced that he was ready to do the same for the Seewarte at Hamburg, by publishing the catalogue of Dove's library.

M. HELLMAN announced that he was ready to do the same for Prussia.

M. CAPELLO announced that he was ready to do the same for Portugal.

M. CANTONI announced that he was ready to do the same for Italy.

The PRESIDENT announced that he was ready to do the same for Russia.

The executive officers of the Committee undertook to communicate this information to the Central Institutions of the countries not represented on the Committee, and to invite them to furnish similar information.

Upon the invitation of the President, M. Hellmann explained the plan of preparation of the Catalogue which he had elaborated, and stated that—

α. The form of the communications that the Committee desired to receive from the different Institutions was to be found in his letter of the 20th January, Appendix VII. (p. 38).

β. The expense of the preparation of the Catalogue was estimated by him at 520*l.* The cost of printing was estimated at 680*l.* for 1,000 copies.

The question was referred to Mr. Scott and M. Hellman, who were requested to consider the means of carrying out the scheme, and to communicate to the Committee the result of their labours.

B. *Catalogue of Observations.*

The Committee requested the Directors of the Central Institutions to state whether they had complied with the wishes of the Congress at Rome, and again called attention to the interest which such a communication would present.

Agreeably to a proposal made by Mr. Symons the Committee requested the Directors of the Central Institutions to print regularly, in one of their publications, a complete list of the works which had been published by their Institutions.

M. Hellmann drew the attention of the Committee to the importance of having the acknowledgments of receipt of works, inserted in the publications of Institutions, as far as possible in accordance with bibliographical principles.

Article VI. of the Programme (the proposed international meteorological tables for reduction of observations) was next taken up.

The following Resolutions of the Roman Congress were read:—

"It is desirable that the International Meteorological Committee should undertake the compilation of fresh uniform tables for the reduction of barometric readings to the level of the sea.

"It is equally desirable that the Committee should undertake the preparation of a collection of tables which may be employed in the meteorological systems of the different countries."

The President submitted to the Committee his proposals for the preparation of international tables of reduction, &c. (App. Ic, p. 16).

Mr. Scott reported that he had recently learnt that Dr. Guyot had a new edition of his tables nearly ready for publication.

M. Mascart submitted two memoirs by M. Angot on the reduction of the barometer to sea level, and on the determination of heights by means of the barometer, which would appear in the Annales du Bureau Central Météorologique.

M. Neumayer submitted a MS. memoir, by M. Köppen, on the reduction of the barometer to sea level.

The President submitted to the Committee proofs of Charts of

the Isabnormals of Temperature which were to be added to his Atlas of the Temperature of the Russian Empire.

The meeting closed at 15 minutes past noon.

(Signed) H. Wild.

Protocol of the Sixth Meeting, Wednesday, 11th August, at 3h. 15m. p.m.

All the members of the Committee were present.

The protocol of the fifth meeting was read and confirmed.

The discussion of Article VI. of the Programme was continued.

The Committee decided upon undertaking the execution of general Tables of Reduction, and nominated a Sub-Committee to prepare the scheme and to draw up a Report.

This Report to be then distributed among the members of the Committee with the view of obtaining their opinion.

After the Committee has again considered the question, the scheme to be distributed to the different chiefs of meteorological organizations in order to obtain further suggestions.

The Committee requests that the chiefs of meteorological organizations will send to the Secretary copies of the Tables in use in their systems.

M. Neumayer reported to the Committee that he was ready to allocate the sum of 20*l.* from the funds of the Seewarte, next year, for the calculation of the tables undertaken by the Committee, on condition that the publication of the work was guaranteed independently of such contribution.

The Committee nominated the President and M. Mascart as members of the Sub-Committee.

Article XV. of the Programme (the discussion of the different resolutions of the Congress of Rome) was then considered.

The several resolutions of the Congress of Rome were read, and the members of the Committee gave information on each of the heads which are printed in Appendix VIII., p. 45.

The meeting closed at 6h. 15m. p.m.

(Signed) H. Wild.

Protocol of the Seventh Meeting, Thursday, 12th August, at 9h. 15m. a.m.

All the members of the Committee were present.

The protocol of the sixth meeting was read and confirmed.

The Committee decided that the Report of the meeting should be published in the three languages, and requested M. Mascart to undertake the publication of the French edition, M. Neumayer that of the German edition, and Mr. Scott that of the English edition.

The PRESIDENT expressed to Professor Forster, who had been requested by the Committee to be present at this meeting, his hearty thanks for the hospitality which he had kindly shown to the Committee by courteously placing the *Observatoire Tellurique* at their disposal, and at the same time he requested him to convey to the Federal Council of Switzerland, as well as to the authorities of the Canton and City of Berne, their sincere thanks for the cordial welcome with which they had honoured the Committee.

In declaring the Second Meeting of the Committee closed, the President thanked the members for the zeal and preseverance which they had brought to bear upon the deliberations, so tha all the questions of the Programme had been dealt with in a satisfactory manner, and that they would have in any case to record on several points real progress in the accomplishment of the task of the Committee.

M. BUYS BALLOT said he was convinced that all the members would concur in thanking the President for the impartial and liberal manner in which he had directed the discussion at the meetings of the Conference. The Conference had asked for and obtained much interesting information, and had opened up other lines of investigation which would be useful for the advancement of science. The President would be the first to rejoice at this because it was in a great measure due to him that the Conference had obtained these results.

The meeting closed at 9h. 30m. a.m.

(Signed)	BUYS BALLOT.
„	G. CANTONI.
„	HANN.
„	E. MASCART.
„	H. MOHN.
„	G. NEUMAYER.
„	J. CAPELLO.
„	R. H. SCOTT.
„	H. WILD.

Berne, 12th August 1880.

APPENDIX I.

Report of the Secretary to the International Meteorological Committee, 1880.

Gentlemen,

In submitting this the first Report of the International Committee it will be simplest to deal with the various subjects in the order in which they appear in the Programme of the Congress at Rome (Appendix XI. to Report of that Congress).

Article III.—The International Committee has not as yet made any advances towards the preparation of a report on the methods of observations and of publication in different countries, but the Secretary has personally prepared a supplement to Appendix V. of the Roman Report on the Organization of the English System in 1876 (printed Appendix IX. to this Report).

Article V. International Publications.—Dr. Köppen has made a proposal as to the mode of publication of the data relating to rain, snow, &c. in the forms adopted. (App. IV., p. 35.)

Article IX.—As regards the proposed Catalogue of Meteorological Publications, letters from Dr. Hellmann and Mr. Symons, and also from Mr. Ramsay, are submitted to the Committee. (App. VII., p. 38.)

As regards the International Dictionary, the Secretary has not received any fresh communications from M. Pittei.

Article X.—As regards the International Comparison of Standard Instruments, a circular (Appendix Ia, p. 13) has been issued to all the principal observatories. Twenty European observatories have already intimated their readiness to join in the scheme and contribute 360 francs apiece. As to America, Mr. Carpmael, of Toronto, states that he is ready to join if the scheme should be extended to America.

At Yale College an Institute for the comparison of instruments has been organised. The organisation is entirely private like that of Kew, in England. The printed prospectus of the institution is submitted to the Committee.

Article XII. (5)—The Report of the Congress has appeared in three languages. The French edition has been prepared by M. Grassi, the German by Dr. Neumayer, and the English by Mr. Scott.

Article XV.—No information has reached the Secretary as to the preparation of any general reduction tables. A note from the President on this subject is submitted to the Committee. (App. Ic, p. 16.)

Article XXVI. B.—The Secretary has not learned what action has been taken by the Italian Government in regard of Meteorology in Brazil; but a letter from Dr. Walz, of Bogotá, in which he addresses himself to the Committee in order to obtain a grant of instruments and funds for the establishment of a Meteorological station, is submitted.

XXVI. C.—As regards the observations at Trevandrum, the regretted death of Mr. Allan Broun has brought the question of the continuation of the publication of these observations to the notice of scientific men in England and India, and the Secretary can assure the Committee that the subject is now under discussion.

Article XXIX.—The Secretary informs the Committee that General Myer has proposed to change the hour from 0h. 43m. G. M. T. to 0h. 8m. G. M. T. from January 1, 1881. Professor Rubenson refers the subject of the advisability of such a change to the Committee.

Article XXX. A.—The Secretary has the honour to inform the Committee that organised attempts are being made by the Meteorological Council to secure meteorological observations in balloon ascents, thanks to the kind co-operation of the War Office, London.

XXX. B. a & b.—The Secretary has not learnt that anything has been done about publishing mountain observations *in extenso*. It is, however, *hoped* that the Agustia Malley observations (Trevandrum) may be published (see Article XXVI. C.)

XXX. B. c & d.—The Secretary has not received any definite information as to the proposed mountain stations in Europe, except as to Mont Cimone and Mont Ventoux, about which printed circulars have appeared.

As to M. Hann's proposal relative to the measurement of glaciers, the Secretary is not aware of any results having been published as yet.

The project has been duly communicated to the Alpine Clubs.

Article XXXI.—The Committee may hope to receive from the International Polar Commission a report of their proceedings since the date of the Conference, Hamburg, in October 1879.

Article XXXII. The Secretary has to report the receipt of a letter from Mr. Parkinson, of the Navigators Islands, with reference to his proposal for a meteorological organisation for the Islands of the Pacific Ocean.

He communicates also the printed report of an Inter-Colonial Conference which has been held at Sydney, in November 1879. (App. Id, p. 16.)

C.—As to the proposed stations in distant Islands, the Secretary has no progress to report.

D.—The same is the case as regards the Sclave countries, Bulgaria, Roumania, and Servia, with the single exception of Ibraila, where M. Hepites makes careful observations and distributes copies to the principal institutions of Europe. At the same time it is to be regretted that according to information lately received from M. Schmidt at Athens there is no present prospect of a meteorological organization for Greece.

Article XXXIII.—The Secretary has to inform the Committee that Mr. Sandford Fleming, Chief Engineer of the Central Pacific Railway in Canada, has proposed the meridian of 150° W. of Ferro, which passes through Behrings Straits, as First Meridian, and that this idea has been already supported by several geographers in Europe, particularly by M. Bouthillier de Beaumont, President of the Geographical Society of Geneva.

Article XXXIV.—The Secretary has to report that invitations have been issued to all the countries of Europe to attend the coming Conference on Agricultural and Forest Meteorology in Vienna (App. Ie, p. 25), and that the names of the Meteorologists who propose to attend have been forwarded to Dr. Lorenz von Liburnau.

Finally, the Secretary has to announce the reception of three communications :—

1. From the President : A proposition as to the exchange of meteorological publications by post.

From M. Hoffmeyer : Two propositions :—

1. On the utility of an international intervention in favour of the laying of telegraphic cables to the Azores and Faroes, Iceland, and Greenland. (App. V., p. 37.)

2. On the importance of the calculation and publications of means and extremes for months, and even for five days, for all international and telegraphic stations. (App. VI., p. 37.)

(Signed) Robert H. Scott,
Berne, 9th August, 1880. Secretary.

APPENDIX Ia.

International Meteorological Committee,

Sir, St. Petersburg and London, April 21, 1880.

We have the honour to inform you that the International Meteorological Committee has decided to promote at once the comparison of standard instruments, viz.: barometers, thermometers, and anemometers belonging to the Central Institutions recommended by the International Meteorological Congress of Rome.

In accordance with the Report presented by M. Wild to the Congress at Rome upon this subject, the Committee proposes the following plan for carrying out the scheme.

1°. For the comparison of barometers and thermometers the executive officers of the Committee would select a qualified person who should visit the Institutions participating in this undertaking, and verify, by means

of standard instruments supplied to him for that purpose, the standard barometers and thermometers of those Institutions. For the comparison of the anemometers a standard instrument will be put into circulation.

2°. The Central Physical Observatory of St. Petersburg will lend the standards necessary for this comparison, viz. : *two* first-class barometers, one a siphon, with millimetre scale, and the other a cistern barometer of Fortin's principle graduated in English inches, two thermometers of different constructions, and a standard anemometer on Robinson's system. These instruments will be verified by the standards of the Central Physical Observatory at the commencement and at the end of all the comparisons. In addition, a very careful comparison will be made at the commencement of the journey with the standards of an observatory in Central or Western Europe, to which recourse may be had, in case of accident, without returning to St. Petersburg. If, on the other hand, the standard barometer and thermometer of the International Office of Weights and Measures at Paris should be ready at the time of the comparison, which is very probable, these would serve as a starting point, and the Committee will then purchase the barometers and thermometers used in the comparison, which will be deposited in the office above mentioned after the journey.

3. Detailed rules will be laid down for these comparisons in order to ensure uniformity. These will be communicated to the Institutions participating, as well as to the person who will undertake the journey.

4. Each Central Institution or observatory taking part in this undertaking will pay to the Committee a sum of 360 francs in addition to the cost of the transmission of the anemometer.

5. This scheme will be carried out as soon as 30 Institutions, or less, have agreed to take part in it.

6. The results of the comparisons will be published by the Committee in several periodical journals.

We hope, therefore, that you will be so kind as to inform Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London) if you intend to take part in this undertaking, for your Institution, on the conditions named, and if so, whether you are ready to pay, upon first demand of the Committee, the proportional quota of 360 francs.

Accept, &c.

H. Wild, President,
R. H. Scott, Secretary,
International Meteorological Committee.

APPENDIX Ib.

St. Petersburg, 9th August, 1879.

At its meeting of the 22nd April 1879, the Second International Meteorological Congress, assembled at Rome, after having deliberated upon Question 31 of its Programme, viz. :

" The Committee after having taken cognizance of the scheme of M. " Weyprecht to establish several observatories in the Arctic and Antarctic " regions so as to organise hourly meteorological and magnetical obser- " vations to be made simultaneously all around the Pole, is of opinion " that these observations will be of the highest importance in developing " meteorology and in extending our knowledge of terrestrial magnetism ; " it thinks, therefore, that in the interest of science, it should recommend " general participation in this enterprise.

" In what manner can the Congress on its part contribute to the success " of the enterprise ? "

made the following resolution upon this question :—

" The Congress recognizes the great importance which should be attri- " buted to synchronous meteorological and magnetical observations made " in the polar regions, by means of simultaneous expeditions, and " it recommends all Governments to give the most effective support " to such undertakings.

" Considering :

" 1°. That the majority of the members of the Congress are not pro-
" vided with instructions relating to this question.

" 2°. That such instructions are absolutely necessary in order to arrive
" at definite resolutions. The Congress decides to entrust the Inter-
" national Committee with the convening of a special conference which
" should be composed of delegates provided with the necessary instructions
" and powers by their Governments, who may think they could participate
" in some way in the enterprise. By reason of the preparations already
" made by M. Weyprecht and Count Wilczek for an expedition of this
" nature, it thinks it necessary that this Conference should meet at Ham-
" burg, on the 1st October 1879, in order to settle the details of the scheme
" and the means of carrying it out."

Conformably to this resolution, the undersigned, in concurrence with M. Neumayer, a member of the International Committee and Director of the "Deutsche Seewarte," at Hamburg, have the honour to inform you that this Conference will meet at 11h. a.m., on the 1st October, at the "Deutsche Seewarte," Seemanshaus, at Hamburg, and request you to do your utmost to realise the wishes of the International Congress, so that your country may take part in this important undertaking by sending to the Conference a delegate furnished by your Government with the necessary instructions and powers.

In our opinion, the Conference will have especially to take resolutions upon the following points :—

1°. The number of observations and the most suitable localities for establishing them. The decision will depend upon the number of countries co-operating, and on the sums which they will devote to this end.

In a scheme dated 30th September 1877, M. Weyprecht and Count Wilczek have drawn attention to the following localities :—

In the Northern Hemisphere :—

Spitzbergen. Northern Coast.
Nova Zembla. Northern Coast.
Finmark. In the neighbourhood of the North Cape.
Siberia. North Coast, at the mouths of the Lena, New Siberia.
Point Barrow, to the N.E. of Behring's Straits. (Occupied by Maguire from.1852 to 1854.)
Greenland. Western Coast. Danish Settlement.
Greenland. Eastern Coast, about lat. 75°.

In the Southern Hemisphere :—

Cape Horn. Neighbourhood of.
Islands of Kerguelen or Macdonald Islands.
Auckland Islands. One of the Southern groups.

2°. The exact period of the commencement of the observations, and their minimum duration.

3°. Uniform instructions for the observations, which will have especially to determine :—

(*a.*) The minimum of the elements to be observed at each station, both for meteorological and magnetical phenomena, and for other phenomena of the physics of the globe which are allied to them.

(*b.*) The minimum number of observations to be made daily for the different elements.

(*c.*) The first meridian, which shall serve as a basis for simultaneous observations.

(*d.*) The methods of observation and the methods of reduction for the different elements.

(*e.*) The instruments of observation and their erection, in so far as they may have an influence upon the comparability of the results.

We hope therefore that you will be so kind as to inform Mr. Scott (Meteorological Office, 116, Victoria Street, London), before the 15th September, whether your country will send a delegate to the Conference at Hamburg, or not.

Accept, &c.

H. Wild, President, St. Petersburg,
R. H. Scott, Secretary, London,
For the International Meteorological Committee.

APPENDIX Ic.

International Meteorological Tables of Reduction.

1°. A comparison of the different thermometer scales, Celsius, Fahrenheit, and Reaumur, both for actual readings, and also for differences of temperature, as far as 0°·01.

2°. Tables for the reduction of barometers to 0°c, for English, with inches and Fahrenheit, and for metric, with millimetres and centigrade, to 0·0001 inch and 0·001 mm. for 0°·1 C. Brass scale.

3°. A comparison of English, old French, and metric barometers, as well as Russian.

4°. Tables for the conversion of English inches and tenths, and Paris lines (rainfall, evaporation, &c.) into millimetres and *vice versâ*.

5°. Tables of the tension of aqueous-vapour.

6°. A table of constants for the dry and wet bulb thermometer readings.

7°. A table for the correction for Gravity.

8°. Tables for the reduction of barometer readings to sea-level.

9°. Tables for the reduction of temperatures to sea-level.

10°. A comparison of wind velocities in kilometres per hour and English miles per hour with metres per second.

11°. Tables for the calculation of height above sea from the readings of the barometer. Tables?

12. Tables for the conversion of heights in English feet and old French feet into metres and *vice versâ?*

13°. Other tables as at the end of Guyot?

The tables are to be according to accurate formulæ and with the most recent constants, calculated to one decimal more than necessary, in order to serve as a basis for less accurate tables in all countries.

The publication to be undertaken by a bookseller. The Committee simply to collect the requisite number of subscriptions, at a fixed price, for the publisher.

H. Wild.

APPENDIX Id

Minutes of Proceedings of the Intercolonial Meteorological Conference, held at Sydney on the 11th, 13th, 14th November 1879.

Tuesday, 11th November 1879.

The Conference met at the Sydney Observatory, at 10 a.m.

Present:

James Hector, Esq., M.D., C.M.G., F.R.S., Inspector of Meteorological Stations, New Zealand; C. Todd, Esq., C.M.G., F.R.A.S., Government Astronomer, South Australia; R. L. J. Ellery, Esq., F.R.S., Government Astronomer, Victoria; H. C. Russell, Esq., B.A., F.R.A.S., Government Astronomer, New South Wales.

H. C. Russell, Esq., was called to the chair.

The Chairman read the following letter:—

Colonial Secretary's Office, Sydney,
8th November 1879.

Sir,

I am directed by the Colonial Secretary at the instance of the Minister of Justice and Public Instruction, to transmit herewith copies of propositions for the consideration of the scientific men nominated by the

several Australian Colonies to consider what means should be adopted to improve the system of intercolonial weather signals.

I have, &c.
CRITCHETT WALKER.

To the Chairman of the meeting of scientific men appointed to consider what means should be adopted to improve the system of intercolonial weather signals.

PROPOSITIONS FOR METEOROLOGICAL CONFERENCE.

1. To consider the meteorology of Australia and New Zealand, with a view to united action in its investigation.
2. To consider whether additional first-class stations shall be established, and if so, in what localities.
3. To consider the desirability of using the same class of instruments at all stations and making the observations at the same local hour.
4. To consider the desirability of securing the co-operation of the meteorologists of New Zealand and Tasmania in the system of weather telegrams, which now embraces the Colonies of South Australia, Victoria, New South Wales, and Queensland.
5. To consider by what means the weather telegrams may be transmitted and published for public information at an earlier hour than they are at present.
6. To consider whether meteorological stations should be established upon the highest available mountains for the special study of winds.

Observatory, 27th October 1879. H. C. RUSSELL.

He said the object for which the Conference had met was to devise some system by means of which more united action might be established in respect to meteorological observations, and especially with regard to weather telegrams. He had experienced great difficulty in obtaining telegrams from the different Colonies with sufficient punctuality, and he thought that if the matter were discussed in Conference some suggestions would be made by which the transmission of these telegrams might be greatly facilitated, and earlier information furnished to the public. Holding this opinion, he had suggested the desirability of having a Meteorological Conference, and the Government of New South Wales had sent invitations to the Colonies of South Australia, Victoria, Queensland, Tasmania, and New Zealand. Queensland and Tasmania had not responded to the invitation, or at least they had not sent representatives. He very much regretted the absence of the representatives of the Colonies of Queensland and Tasmania, but thought the Conference should proceed with the business before them.

UNITED INVESTIGATION OF METEOROLOGY.

To consider the meteorology of Australia and New Zealand, with a view to united action in its investigation.

Mr. Ellery thought it would be well to start by affirming the desirableness of united action, and he would therefore move formally, before entering upon other questions, the following resolution in reference to the first proposition :—

That in view of the great importance which a better knowledge of the movement and origin of strong gales and storms on our coast lines and neighbouring seas is to the shipping and commercial interest generally, it is desirable to secure, as far as possible, co-operation in all the Australasian Colonies for the investigation of storms, as well as for agricultural and general climatological purposes.

It had already been shown that the westerly gales which visit New Zealand and the easterly gales occurring on the coast of Australia were marked by premonitory signs ; and some co-operative action in the transmission of information could not fail to lead to profitable results.

The resolution, after discussion, was agreed to.

Dr. Hector moved :—

That with the view of giving effect to the foregoing resolution, similar

observations and the same form of publication should, as far as possible, be adopted throughout the Colonies.

He explained that he did not mean that no other form of observations should be published, but that the Government of each Colony should be asked to sanction the expense of publishing certain observations taken at the same local hour in the form required by the Conference, so that they could be compared with each other.

The resolution, after discussion, was agreed to.

First-class Stations.

The Chairman read the second proposition :—

To consider whether additional first-class stations shall be established ; and if so, in what localities.

He thought the Conference should free themselves from the task of defining what constituted a first-class station, as circumstances might arise to alter their opinion on that point.

Mr. Todd : There would in reality be only one first-class station in each Colony, which would be the Observatory.

Mr. Ellery did not think it would be desirable to lay down any fixed rule on this point. The different Colonies worked under different circumstances, and all that was required was to secure their co-operation.

Dr. Hector thought the number and position of the different stations should be left for each Colony to determine. The Conference should not dictate to the Colonies what expenditure they should incur ; nor did he think they should lay down any expensive or elaborate scheme which might have the effect of preventing cordial co-operation.

The chairman said his object in submitting this proposition was to suggest one or two more stations in the western district. It would be seen in the map that there was a scarcity of stations in the interior ; and as most of the atmospheric disturbances came from the west, the establishment of additional stations there would supply valuable information.

Mr. Todd moved :—

That in order effectively to carry out the objects of the Conference as affirmed in the foregoing resolution, it is desirable to establish first-class meteorological stations in certain well-selected positions in the several Australasian Colonies, including New Zealand, in addition to those now existing.

The resolution, after further discussion, was agreed to.

On the motion of Dr. Hector, the Conference adopted the definition of the work of a first-class station given in the preface to the New Zealand Meteorological Report for 1873.

"The observations taken are limited to those for determining atmospheric pressure ; maximum and minimum daily teperature of atmosphere, and of insulation and radiation ; the average daily amount of moisture, the rainfall and number of rainy days ; the force and direction of wind, and amount and character of cloud."

Similar Instruments.

Third proposition :—

To consider the desirableness of using the same class of instruments at all stations, and making the observations at the same local hour.

The Chairman said he was aware that in some cases instruments of different kinds were used, and thus the results were not comparable. He did not think temperature observations could be exact at all stations—a different way of exposing the thermometers made such a difference in the result. With regard to the barometer, it would be sufficient to say that it should be a mercurial barometer and not an aneroid ; and with respect to the wet and dry bulb, it should mean an instrument of good class, certified to by a firm of recognized position, and the same with regard to the maximum and minimun thermometers ; and the rain-gauges should be used at the same altitude from the ground.

Mr. Ellery moved :—

That the instruments at each first-class station consist of a mercurial barometer of either the Standard or Board of Trade form ; thermometers

of Kew, or approved, patterns, compared with standards as frequently as possible; rain-gauges of 8 inches collecting diameter; and wind-gauges of any approved form. The local hours of observation to be 9 a.m., 3 p.m., and 9 p.m. Beaufort's scale of wind to be adopted; the observations to be recorded in equivalents in velocity and pressure.

The resolution, after discussion, was agreed to.

Desirability of Co-operation.

Fourth proposition :—

To consider the desirableness of securing the co-operation of the Governments of New Zealand and Tasmania in the system of weather telegrams, which now embraces the Colonies of South Australia, Victoria, New South Wales, and Queensland.

Mr. Ellery said, with regard to Tasmania, that for the meteorological knowledge of that Colony they were indebted to the long and valuable gratuitous services of F. Abbott, Esquire, of Hobart Town. But in order to provide for carrying out the proposed scheme, which involved a daily expenditure for telegrams, he would move : That it is very desirable to obtain the co-operation of the Government of Tasmania, and to persuade them to establish a station at the public expense at Hobart Town. He did not think this would be a difficult matter if the Conference suggested it. At present there was no machinery to co-operate with, and it was very desirable that one or two first-class stations should be established. He thought it would be better not to take Launceston for a second station, which was a long way inland, but rather to take George Town.

The resolution, after discussion, was agreed to.

Dr. Hector moved :

That it is desirable to secure the co-operation of the Governments of Western Australia, New Zealand, and Tasmania, in the system of weather telegrams, which now embraces the Colonies of South Australia, Victoria, New South Wales, and Queensland.

With regard to New Zealand, on account of the greater expense of communication, the great range of latitude, and the consequent complicated phases of weather which occurred simultaneously in the different coastal areas, it was desirable that instead of any different observations or reading of instruments being transmitted, a daily synoptical report of the general conditions of the weather should be prepared at the Head Office in New Zealand and transmitted, together with immediate telegraphic notice of any important or exceptional phenomenon; and that the return communications to New Zealand should be comprised in a similar synoptical report of the state of the weather in the different coastal areas of Australia, to be prepared and transmitted from the Observatory in Sydney.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

That, in the opinion of this Conference, it is desirable that weather telegrams and forecasts shall in all cases depend upon the observations used for general meteorological and climatological statistics, and be under the direction of the head of the meteorological department in each Colony.

Mr. Todd thought such a resolution was essential to prevent conflicting reports and to ensure public confidence.

The resolution, after discussion, was agreed to.

The Conference adjourned at 1 p.m., until Thursday, 13th instant, at 10 a.m.

Thursday, 13th November 1879.

The Conference met at the Observatory at 10 a.m.

Present :

Dr. Hector, Mr. Ellery, Mr. Russell, Mr. Todd.

H. C. Russell, Esq., in the Chair.

The minutes of the previous meeting were read and confirmed.

The Conference resumed their consideration of the 4th proposition, affirming the desirableness of securing the co-operation of the New Zealand and Tasmanian Governments in the system of weather telegrams.

Mr. Todd moved :—

That this Conference, having been informed that the Eastern Extension Telegraph Company will charge half rates for the transmission of weather reports through the cable connecting Australia and Tasmania, and probably also the cable to New Zealand, recommend that the cost of such reports be defrayed by the participating Colonies in equal proportions ; and that in the opinion of this Conference, such cost need not exceed in the aggregate 350*l.* per annum.

2. That, in the opinion of the Conference, this expenditure is justified by the extreme importance to the shipping interest of early information of the approach of dangerous easterly and westerly gales.

He said that as these reports transmitted through the cable would be merely synoptical reports of the state of the weather in Australia on the one hand, and in New Zealand and Tasmania on the other, they need not be of great length. Messages comprising ten or twelve words would probably, by means of the code adopted, convey all the information that would be required. A message of ten words would cost—to or from New Zealand—at the reduced rate, about five shillings. The amount named in the resolution would therefore, in his opinion, be ample.

The Chairman said, that from the experience in reference to gales which he had obtained during a number of years, it was quite evident that from the observations taken in New Zealand and the southern Colonies valuable warnings might be given. A short warning of the approach of a gale in many instances would be the means of saving a large amount of property, as the vessels could take refuge in the coast harbours. Warnings of dangerous gales might be given several days in advance, and considerable importance was attached to such information by the shipping interest. For instance, in the severe gale in which the "Dandenong" was wrecked, it had subsequently appeared that valuable information might have been given sufficiently in advance to prevent the great loss of property which took place, if that information could have been furnished to the shipping interest at the different ports along the coast.

Mr. Todd entirely concurred with the Chairman as to the importance and value of this information, and especially of the reports from western stations. His observations tended to show a great regularity in the easterly march of disturbances from the westward, and the stations in South Australia, and especially in Western Australia, should be able to give the easterly Colonies timely warning of approaching gales, because they would be able to report the effect of a gale which had already reached one of these stations. The information would therefore not be hypothetical, but an actual fact of which timely notice could be given.

Dr. Hector said that from a New Zealand point of view, he thought it would be very advantageous that Queensland should join in this co-operation, as it would be from that quarter they would receive early notice of the origin and progress of the dangerous and suddenly occurring cyclones that crossed the northern part of New Zealand. On the other hand, the southerly gales could not, of course, be directly predicted in Australia for New Zealand, but New Zealand could give early information to Australia of the occurrence of such gales, and probably Queensland would receive the greatest benefit from such predictions.

Mr. Ellery said that in that view of the case, great advantage would be derived from the establishment of a station at Hobart Town, because if Hobart Town observations were discussed in connexion with this movement on the western coast of Australia and the subsequent weather on the east coast, it would be found that those observations would often determine whether that easterly movement had been deflected by any other current. The observations at Hobart Town would indicate a considerable time beforehand whether the disturbance would become a serious one on the eastern coast of Australia. For instance, it was a fact that the gale in which the "Dandenong" was wrecked was indicated at Hobart Town thirty hours before it reached Sydney.

Mr. Todd called the attention of the Conference to the hurricane which struck the Lacepede Islands and the north-west coast of Australia on the 24th and 25th of December, 1878, as a case in point. The barometer fell to 29·50 and 28·94 ; at Alice Springs, in the centre of the continent, it began to fall on the 30th, reaching 29·6 on the morning of January 2nd ; at Eucla, the barometer fell from 30·2 on December 29th, to 29·50 on January 1st ; at Cape Borda, it fell from 30·23 on December 30th, to 29·53 at midnight on January 1st ; at Cape Northumberland, it fell from 30·2 on the morning of 30th December, to 29·35 at 6 p.m on January 2nd, or six hours after Cape Borda ; and the barometer fell to 29·30 at Hobart Town in the afternoon of January 2nd, or about 24 hours after passing the Great Bight. The storm between the Great Bight and Hobart Town was probably identical with, or the subsequent effect of, the hurricane on the north-west coast, in which case it must have had a slow progressive motion over the Australian continent, between the north-west coast and the Australian Bight, emerging from the coast at about the Great Bight, and occupying 24 hours in passing from the Great Bight to Hobart Town.

The resolution was then agreed to.

Weather Telegrams.

5th proposition :—

To consider by what means the weather telegrams may be transmitted and published for public information at an earlier hour than they are at present.

The Chairman said the idea which was present to his mind in submitting this proposition was to suggest that weather telegrams should, in Australasia, as in Europe, take precedence of all other telegrams. This arrangement would not add in any appreciable respect to the time occupied in transmission, and the delay of five or six minutes caused by sending these messages first could not be any serious detriment to business. He thought it probable that if the matter were represented by the Conference to the several Governments, the general principle would be adopted, and weather telegrams would take precedence of all other messages, Government telegrams of course excepted.

Mr. Todd entirely concurred with the Chairman in thinking it highly desirable that weather telegrams should have the precedence, and he saw no practical difficulty in giving effect to the resolution. No doubt the hour which had been agreed to—9 o'clock—might appear at first sight to clash with the ordinary routine business at the telegraph offices ; but as a matter of fact, with the exception of the transmission of messages from the different stations to the central office at 9 o'clock, there would be no reports sent at that hour. It would probably be 11 o'clock before all these messages would be received at the central office. In his case it was generally a quarter-past 10 before he could send any weather reports to the other Colonies. In the case of Western Australia it was still later, on account of the difference in longitude. So that the sending of these weather reports would not really clash with the Office reports, and there was no reason why they should not be transmitted immediately, and take precedence of all private messages. He thought it only required to be properly represented to the different Governments, so that the telegraphic departments might be instructed that the weather reports were to take precedence, and the telegraph superintendents in the different Colonies would be relieved from any responsibility in the matter. It should be borne in mind that by the adoption of the cypher code, the messages were reduced to the minimum in point of length.

He would now move—

That the several Governments be requested to cause precedence to be given to the regular weather telegrams and special storm reports.

Dr. Hector said, that in New Zealand they had three kinds of telegrams—"urgent," "ordinary," and "delayed." The public could take advantage of this scale, and by paying two shillings could make a telegram urgent. Messages arriving in the evening could be sent as delayed telegrams in time for the morning post.

Mr. Ellery said the value of weather information was lost in many cases by delay, while it was increased in proportion to the punctuality with

which it was furnished. He might state that in his last Annual Report he had made reference to the procedure in America and several European States who had at first to be coaxed into allowing weather telegrams to take precedence, but they now generally accorded it. Weather telegrams were of no value to the shipping and commercial interest unless they were transmitted punctually. In Victoria the Chief Secretary had entered into correspondence with the Telegraph Department of that Colony on the subject, and precedence had always been accorded. He thought it would only be necessary to bring the matter before the several Colonial Governments. The only difficulty would lie with the Telegraph Departments themselves.

The resolution was agreed to.

Mountain Stations.

6th proposition :—

To consider whether the meteorological stations should be established upon the highest available mountains, for the special study of winds.

The Chairman said, his object in putting this proposition before the Conference was to obtain if possible records of the winds that passed overhead, and were therefore lost to the records of the lower stations.

From observations made years ago by Strzelecki, it appeared that at the top of Mount Wellington he had noticed a hot wind which was not felt at all 3,000 feet lower on the same mountain ; and from similar observations in this Colony it appeared that hot winds were frequently felt at the high stations and not at those which are at a lower level.

Similar facts might be stated with regard to the south-east gales, which frequently appeared first at lofty stations. He thought these facts were a sufficient reason for the establishment of stations on high mountain peaks,—the only means which appeared to him available to secure the desired information.

Mr. Ellery moved :—

That, in the opinion of this Conference, there should be established in each of the Colonies, upon a high mountain peak, a meteorological observatory for the special study of winds and other meteorological phenomena :

And that the most desirable positions for them would be the following :—

		About	
South Australia—Mount Lofty	-	2,500	feet above sea level.
New South Wales—Kiandra -	-	4,600	,,
New Zealand—Tauhara Taupo	-	4,600	,,
Do. Mount Herbert	-	4,000	,,
Tasmania—Mount Wellington	-	4,000	,,
Victoria—Mount Macedon -	-	3,500	,,

The resolution, after discussion, was agreed to.

The Conference adjourned at 1.15 p.m., until to-morrow, Friday, 14th instant, at 9 o'clock a.m.

Friday, 14th November 1879.

The Conference met at the Observatory, at 9 a.m.

Present :

Dr. Hector, Mr. Ellery, Mr. Russell, Mr. Todd.

H. C. Russell, Esq., in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. Todd moved :—

That the revision of the present telegraph weather code be referred to Messrs. Russell and Ellery, with a view to its simplification and extension.

The resolution, after discussion, was agreed to.

Dr. Hector moved :—

That the interchange of weather statistics, in carrying out the suggestions of this Conference, between the different Australasian stations should be in the form of a diagram, and that this should not interfere

with the printing of statistics by the different Colonies in any way they like.

He would at the same time strongly recommend that some uniform system of publication should be gradually approximated.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

1. That the monthly graphic records for interchange consist of curves, showing—

Barometer,
Velocity and direction of wind,
Temperature,
Humidity,
Rainfall,

with remarks upon weather, especially with reference to storms and atmospheric disturbances, and that specific forms be prepared and distributed to the co-operating Colonies.

2. That the mean humidity curve be derived from the means of maximum and minimum of wet and dry bulb thermometers.

3. The barometer curve to be constructed from barographic records, so as to depict the turning points.

4. The temperature curve to represent maximum and minimum and mean for each day.

5. The velocity and direction of the wind to be deduced from the anemometer.

The resolution was, after discussion, agreed to.

Dr. Hector moved :—

That, in the transmission of cablegrams, the reports be generalized from the local weather reports.

For New Zealand the following subdivision into districts is recommended for convenience of reporting :—

A. - -	N.E aspect - -	North Cape to East Cape.
B. - -	N.W. aspect - -	Cape Maria to West Cape (exclusive of Cook Straits).
C. - -	S. aspect - -	West Cape to Moeraki.
D. - -	S.E. aspect - -	Moeraki to East Cape (exclusive of Cook Straits).
E. - -	Cook Straits - -	Comprising Wanganui, Wellington, Cape Campbell, and Cape Farewell, Nelson.

A code to be framed to express the weather in each of the above aspects in general terms, according to the judgment of the reporter, thus—

Aspect.	Wind and Weather.	Rain.	Sea.

No remark to indicate absence of marked phenomena.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

That the cablegrams furnished to Melbourne by Tasmania should conform with those between the Australian Colonies.

The resolution was, after discussion, agreed to.

Mr. Todd moved :—

1. That weather telegrams from the Australian Colonies shall comprise—

(1.) Barometer reduced to 32° and sea level,
(2.) Dry bulb,
(3.) Humidity,
(4.) Maximum and minimum,
(5.) Direction and velocity of wind,
(6.) State of weather,
(7.) Rainfall,
(8.) Sea disturbances,

with a synoptical report of the weather generally.

2. And that within New Zealand the same system should be adopted.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

That the extreme importance of the weather system proposed be strongly urged upon the Queensland Government, with a view to obtain their more active co-operation.

The resolution was, after discussion, agreed to.

It was further resolved,—

That Australia be divided into six meteorological areas for transmission of reports to New Zealand, viz., Western Australia, South Australia, Victoria, New South Wales, and Queensland, South Australia being divided into two districts, tropical and extra-tropical.

The Conference adjourned at 11.80 a.m., until half-past 7 o'clock the same day.

———

The Conference met again at 7.30 p.m.

PRESENT :

Dr. HECTOR, Mr. ELLERY, Mr. TODD, Mr. RUSSELL.

H. C. RUSSELL, Esq., in the Chair.

The minutes of the previous meeting were read and confirmed.

It was resolved,—

That weather telegrams be written on paper of a special colour, so as to be readily distinguishable in the offices.

Mr. Todd moved :—

1.. That the solar radiation thermometers should be blackened bulb thermometers in vacuo, and should be exposed on an open space at an elevation of 4 feet 6 inches from the surface of the ground, supported by a post carrying two light arms.

2. And that radiation thermometers be placed over grass.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

That the following subjects for experiment be referred to each member of the Conference, for future consideration and report :—

1. Shade temperature.
2. Swinging thermometer and thermometer sheds in use.
3. Standards to be swung with 2 ft. 6 in. string during sunshine and after sunset.
4. Observations to determine the difference in humidity by self-registering maximum and minimum thermometers, and by other methods.
5. The best method of measuring the velocity and pressure of wind.
6. Whether any better method than black bulb thermometers can be devised for measuring the direct effect of the sun.
7. As to the best method of determining spontaneous evaporation.

The resolution was discussed and agreed to.

Mr. Ellery moved :—

That as investigation of the Newcastle tide-gauges has shown that such instruments give valuable indications of distant earthquakes, gales, and sea disturbances, it is desirable, in the opinion of the Conference, that self-registering tide-gauges be established in as many convenient places as possible on the coast, in connection with the Meteorological Departments of the different Colonies.

The resolution was agreed to, after discussion.

Dr. Hector moved :—

That the foregoing minutes be adopted as the report of this Conference on the various matters referred to it, and that the Chairman be requested to report to the Government of New South Wales.

H. C. RUSSELL.
ROBT. J. ELLERY.
CHARLES TODD.
JAMES HECTOR.

APPENDIX Ie.

International Meteorological Committee,
St. Petersburg and London, 8th April 1880.

CONFERENCE FOR AGRICULTURAL AND FOREST METEOROLOGY.

At its meeting of the 22nd April 1879, the second International Meteorological Congress assembled at Rome, after having deliberated upon Question 35 of its Programme, viz. :—

" How can the development of meteorology in connexion with agriculture and forestry be forwarded by the Congress ? "

passed the following resolution :—

"In order to contribute to the progress of agricultural and forest meteorology, the Congress recommends as a programme for study :—

"1°. The influence of the meteorological elements upon vegetation.

"2°. The inverse influence of vegetation upon the meteorological elements.

"3°. Agricultural warnings.

"The Congress finding the subject too important to take a detailed resolution at this meeting, proposes to charge the International Committee with the convening of a special International Conference before next spring, to take into consideration the development of agricultural and forest meteorology."

Agreeably to this resolution, the undersigned, in concurrence with Dr. Lorenz von Liburnau, Chief of the service of Forest Meteorology in Austria, have the honour to inform you that such a Conference will meet on the 6th September, at 11h. a.m., in the building of the Academy of Sciences at Vienna, and will last, probably, five days. The members of the Conference are also invited to take part in a preliminary meeting on the 5th September, at 5h. p.m., in order to settle the Agenda for the general meeting of the following day.

In inviting you to be good enough to take part in this Conference, either personally, or by sending another competent person who will be able to represent your Institution, we request you to inform, as soon as possible, Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London) of the name of the gentleman who will participate on your part at the Conference of Vienna.

We annex for your information a preliminary programme of the questions to be discussed by the Conference.

Accept, &c.
H. WILD, President.
R. H. SCOTT, Secretary.

For the International Meteorological Committee.

N.B.—Agreeably to the desire expressed by the Congress, the Conference was fixed by the first invitation issued by one of us for the 18th May, but has had to be postponed until the date stated above, for reasons independent of M. Lorenz and at the desire of many persons interested.

PROGRAMME of the CONFERENCE at VIENNA for the DEVELOPMENT of AGRICULTURAL and FOREST METEOROLOGY.

The object of the Conference for Agricultural and Forest Meteorology is not only to instigate new methods and investigations in this special branch of Meteorology, but also to determine, with greater accuracy than at present exists, the part which existing central meteorological offices, with their systems of ordinary stations, can take in the development of this brach of meteorology by their observations and investigations, and also to consider the ways and means of organising this participation in the best manner. Accordingly the proceedings of the Conference are to be especially concentrated upon the following points :—

I. What are the mutual relations between the meteorological elements and vegetation, not only those already investigated, but those theoretically supposed to exist.

II. To what observations of meteorological elements is particular attention to be paid, with special reference to their influence on vegetation?

III. To what extent and how, can meteorological observatories and stations include such observations in the sphere of their operations, without hindrance to their activity in other directions?

IV. Would it not be desirable, with a view to special observations which must be undertaken, as 'e.g.' phenological observations, to prepare a general form of Instructions?

V. Can Meteorological Institutes at present issue weather forecasts for the use of agriculturalists with any prospect of success? And if the answer should be in the affirmative, how should the service be organized so as to attain this object as fully as possible?

Preliminary materials for the answers to these questions will be found in the Reports of Dr. Lorenz von Liburnau, and of Dr. C. Bruhns, to the Second International Meteorological Congress at Rome, on Article 35 of its Programme. These reports have been published separately in German, and also, in abstract, in French in the collection of all the reports to that Congress issued by the Central Meteorological Office at Rome. In the same collection a report of M. le Père F. Denza on this question is printed.

APPENDIX II.

INTERNATIONAL METEOROLOGICAL COMMITTEE.

SIR, St. Petersburg and London, 28th May 1880.

CONFORMABLY to the instructions of the International Meteorological Congress at Rome, we have the honour to inform you that the International Meteorological Committee appointed by that Congress will meet for a first session on the 9th August 1880, at Berne (Switzerland), and that, up to the present time, the following subjects have presented themselves for discussion at this meeting :—

1°. The Report of the Secretary on the action of the Committee since the Congress at Rome.

2°. The Polar Conference held in the month of October 1879 at Hamburg.

3°. The Conference for Agricultural Meteorology, convened for the 6th September 1880 at Vienna.

4°. The proposed comparison of the standard instruments of the observatories in Europe.

5°. A general catalogue of the meteorological observations and of the meteorological works and memoirs of all countries.

6°. International meteorological tables for the reduction of observations.

7°. The international meteorological dictionary.

9°. A Supplement to Appendix V. of the Report of the Congress at Rome concerning the organization of the Meteorological Service in England in 1876, by Mr. Scott.

9°. A proposal made to the Committee by Captain Hoffmeyer respecting an international telegraphic service for the North Atlantic.

10°. A proposal relative to the exchange of meteorological publications through the post.

In case you should desire to present to the Committee any proposal, or any remarks upon any of the questions, you are requested to be good enough to forward them in time to Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London).

Accept, &c.

H. WILD, President.
R. H. SCOTT, Secretary.
For the International Meteorological Committee.

Questions added subsequently :—

11°. A proposal by Captain Hoffmeyer respecting the publication of the means and extremes of the meteorological elements for international and telegraphic stations.

12°. A proposal by M. Köppen as to the publication of data for rainfall, &c.

13°. M. Rubenson's letter respecting the change of the time of the simultaneous observations proposed by General Myer.

14°. The daily interchange of observations made at various stations, proposed by M. E. Renou.

15°. A discussion of the different resolutions of the Congress of Rome.

APPENDIX III.

Berne, 10th August 1880.

I HAVE the honour to submit to the International Meteorological Committee the accompanying copy of the protocol of the proceedings of the second Polar Conference, which was held here from the 7th to the 9th instant.

When I sent the subjoined protocols and a summarised report of the proceedings of the first International Polar Conference to the President of the International Committee on the 13th January last, I took the opportunity to request, in the name of the International Polar Commission, the assistance of the Committee in carrying out the decisions of the former Conference. And again to-day I address this request to the Committee, in the name of the Polar Commission, pointing out specially, at the same time, that it will be of extreme importance to obtain the participation of the countries not represented at the two Conferences in the plan of Polar research, and also to ensure the support of the Committee therein.

As will be seen from the protocols, a report of the recent Conference will be drawn up and published, to which a lithographed copy of the accompanying protocols will be appended. This can, of course, only be done after the lapse of some weeks, while it is the decided wish of the Conference that the matters discussed by it may be discussed at this meeting of the International Meteorological Committee. Under these circumstances, I can only hand in a copy of the protocols, to which I add a resumé of the most important results of the Conference.

The results may be stated as follows —

1°. Although the question of participation in the plan of Polar research has only been accepted in a definite form by a few countries, it may, however, be affirmed that the sympathy with the scheme and the probability of a sufficient participation for the carrying out of the same have made considerable progress during the ten months which have elapsed since the Hamburg Conference.

2°. The second Polar Conference adheres almost entirely to the decisions taken at Hamburg, both as regards the general principles and also the details for carrying out the great plan.

3°. The impossibility of preparing the preliminary arrangements for the individual expeditions within the space of time fixed by Paragraph 13 of the first Report, has induced the Conference to decide that the execution of the whole plan shall be deferred for a year, and fixed for the autumn of 1882-3.

In conclusion I have the honour to inform the Committee that from many considerations, partially expressed in the protocols, I have decided to resign my office of President. In my place, Prof. Wild, as President of the International Meteorological Committee, who was elected a member of the Polar Commission in the preceding meeting, was unanimously chosen at the meeting of the 9th August as President of the Commission.

G. NEUMAYER.

To the International Meteorological
Committee, Berne.

Report of the Discussions and Resolutions of the International Polar Conference held at Hamburg from the 1st to the 5th October 1879.

The second International Meteorological Congress, which assembled at Rome in the month of April of that year (1879), at its meeting of the 21st April, by a resolution, and in compliance with a proposal made by the 5th Sub-Committee, charged the International Meteorological Committee with the convening of a special Conference at Hamburg on the 1st October, of that year, to consider the scheme of MM. Wilczek and Weyprecht, for a systematic and scientific exploration of the Polar regions.

In pursuance of this charge, the executive officers of the Committee addressed, on the 9th August of that year, an invitation (contained in Appendix I.) to all the former members of the Congress and to a number of public and private scientific institutions.

This invitation requested participation in the Conference, and requested at the same time all those who intended to take part in it to inform Mr. R. H. Scott, Secretary of the International Committee, or Dr. Neumayer, Director of the Deutsche Seewarte, thereof. The latter gentleman undertook the necessary arrangements for the Conference. In accordance with the wish expressed in the above-mentioned resolution of the Meteorological Congress, a note was added to the invitation, requesting the members of the Conference to provide themselves with instructions from their respective Governments or Societies. The object of this note was to facilitate discussion, and especially to call together only such delegates that might have powers from their respective authorities of promising, in some way or other, an efficient participation in the undertaking to be promoted by the Conference.

In consequence of this invitation, but also of the restriction contained in the note referred to, a number of replies arrived at the end of last September (1879), of which eight or ten only gave a prospect of participation.

On the 1st October, at 11h. a.m., conformably to the invitation, the members whose names follow in alphabetical order assembled at the Conference in the building of the Deutsche Seewarte.

1°. Professor Buys Ballot of Utrecht, delegate of the Ministry "Waterstaat Handel-en Nyverheid," for Holland.

2°. Captain Hoffmeyer, of Copenhagen, delegate of the Royal Ministry of Marine, for Denmark.

3°. Professor Lenz, delegate of the Imperial Geographical Society of St. Petersburg.

4°. Professor Mascart, of Paris, delegate of the Ministry of Public Instruction of France.

5°. Professor Mohn, of Christiana, delegate of the Royal Norwegian Ministry of Instruction, for Norway.

6°. Professor Neumayer, Hamburg, and

7°. Captain von Schleinitz, of Berlin, delegates of the Imperial German Admiralty, for Germany.

8°. Lieutenant Weyprecht, of Trieste, for Austria, with full powers from the Imperial Ministry of Instruction to take part in the meetings, and as delegate of his Excellency Count H. Wilczek.

9°. Dr. Wykander, of Lund, delegate of the Royal Academy of Sciences of Stockholm, for Sweden.

M. Neumayer welcomed the meeting in a short speech, in which he explained the importance of the Conference for the advancement of the physical sciences; he expressed the hope that the discussions which were about to take place would produce satisfactory results for the carrying out of the undertaking in question, and at the same time recapitulated the history of the origin of this Conference. He then read the letters which he had received, respecting the participation or non-participation in the Conference. Among the latter the following are quoted in the Appendix to this Report, under Nos. 2, 3, and 4, because they give reason to hope for an eventual co-operation in the proposed undertaking; these are :—

A letter from General Myer to M. Weyprecht.

A letter from Mr. Kingston of Canada, to Mr. Scott.

A letter from Commander Cheyne to Mr. Scott.

After these preliminary and purely routine details, M. Neumayer proposed to the members to constitute the executive officers of the Conference by the election of a President and Secretary. This proposal was adopted, and M. Neumayer was elected President, and M. Hoffmeyer, Secretary. After its constitution, the Conference commenced its sittings immediately, and in the first place the special treatment of measures to be dealt with, and especially the nomination of a sub-Committee was decided upon, which should be charged with the drawing up of a general programme. This Sub-Committee was composed of MM. Mohn, Weyprecht, and Wykander.

At their first meeting it was deemed necessary to take cognizance of the powers with which the different members of the Conference were invested, and they were invited to state how far their instructions went.

The result was, as stated in the protocols, that the representatives of the different Governments and Societies were not actually in a position to make definite promises, but that it might be affirmed generally, that in influential circles, if the participation were sufficiently large, there was a desire to co-operate in one way or another in the accomplishment of the resolutions arrived at by the Conference, the object of which was a scientific exploration of the Polar regions.

The remaining five meetings of the Conference took place on the 2nd, 3rd, 4th, and 5th of October, and in order to terminate the proceedings as quickly as possible, two meetings were held on the last-mentioned day.

The protocols of the proceedings were lithographed and placed in the hands of the different members of the Conference as quickly as practicable. These protocols are added to this Report as Appendices Nos. 5, 6, 7, 8, 9, and 10 (not printed here). As the Conference has resolved at its 4th meeting, on the 4th of October, that the protocols composed in the German language should be considered as the original edition, reservation was made that, without prejudice to the translation into any other language, a French translation especially should be given.

With reference to the resolutions taken by the Conference, these are conveniently separated into two groups, firstly, into those decisions which belong to a general nature; and secondly, into those embracing in detail the programme of the work in the Polar regions, and the manner of executing it. In the general part are to be included those decisions which refer to the extension of the participation in the scheme, and the steps necessary to effect that object. In the following summary the various decisions of the Conference are collated and presented in accordance with the classification indicated, without reference to the order in which they were proposed and adopted.

I.—General Part.

1°. The object of the undertaking which occupies the Conference is in the first place the investigation of the meteorological and magnetical, and generally the physical conditions of the Polar regions, and the immediately contiguous zones of the earth, according to a uniform plan to be determined by international agreement.

2°. These investigations are to be carried out especially at certain stations, and at fixed observatories to be established at the same, and commencing operations at the same time.

3°. The expenses of establishment and maintenance of such station or stations are to be borne by the country (or persons participating) undertaking their establishment.

4°. As a justification of the importance of the undertaking it should be set forth :—

(*a.*) *From a meteorological point of view*, that without an exact knowledge of the occurrences and phenomena which take place in the Polar regions, we cannot think of the possibility of establishing general principles and theories relating to the pressure of the air, the distribution and variations of temperature and air currents, the

development and change of weather, or general climatological laws.

For the northern hemisphere, and especially for the meteorological phenomena in North America, Northern Europe, and Northern Asia, this proposal is evident *á priori*, and may be immediately demonstrated by a study of synoptic charts and of the results of simultaneous observations. Owing to the close connection of the Antarctic regions—undisturbed by continental influence—with the contiguous districts of higher latitudes within which the international traffic by sea is carried on, the establishment of general laws, on the one hand, can be essentially promoted, in consequence of the homogeneity of the earth's surface, whilst, on the other hand, the extension of meteorological investigation towards the south, by the further development of science cannot be dispensed with.

Especially important is the extension of the domain of synoptic, that is, of simultaneous meteorological work, towards the Arctic regions, for the development of the prognostication of weather and storms for the whole of Europe and North America.

(*b.*) From the standpoint of the science of terrestrial magnetism, that simultaneous observation at stations chosen according to certain points of view to be determined upon, in both Polar regions, for the development of the theory of the disturbances in the magnetic elements, whose relations to Aurora and sunspots is a condition without the fulfilment of which no decided advance in our knowledge can be hoped for.

(*c.*) That for the knowledge of the distribution of the magnetic force of the earth, and its secular and other changes over the earth, a thorough investigation at a definite epoch of the present time is evidently indispensable.

(*d.*) That the hydrography of the oceans—the theory of the distribution of heat and currents—is wanting in those fundamental factors by the help of which alone a scientific foundation, sufficing for all requirements, can be obtained, so long as a thorough examination of the polar regions, by means of accurate instruments, does not exist.

(*e.*) That the knowledge of the figure of the earth is incomplete, and rests partly upon hypothesis, so long as no certain measurements exist, according to the most recent methods, in the polar regions and especially in the northern hemisphere.

5. It is shown sufficiently from these concise arguments, given to justify the importance of systematic scientific researches in the polar regions, that in almost all branches of science, and other reasons drawn from the natural sciences could be added to the list, the progress of human knowledge will be limited and retarded without the extension of scientific facts by means of observations in those parts of the earth.

6. With respect to the natural sciences generally, the Conference has to impose upon itself certain limits, because it represents especially the interests of meteorology and terrestrial magnetism ; but it is also its duty to make further limitations with regard to these branches of science.

7. In order to ensure the attainment to the end proposed, the Conference deems it expedient, with reference to the physical sciences, to distinguish more minutely between compulsory and special observations.

8. Compulsory observations are those which must absolutely be taken, if the system of observation is not to remain incomplete, and omissions to arise which would materially compromise the deduction of general results, and presumably even make them impossible. These comprise all meteorological and magnetical observations, observations of the aurora borealis, and hydrographical surveys, in which simultaneity must be held as a first condition.

9. The domain of special observations cannot be here precisely determined, because this would be synonymous with a catalogue of all the sciences interested. It will suffice here to draw attention to some individual observations ; such as pendulum observations to determine the figure of the earth ; hydrographical observations made at the fixed stations attached

to the expeditions; astronomical determinations, referring to atmospheric refraction; the radiant points of meteors, &c.

10. With respect to the choice of places of observation (stations) the Conference unanimously arrived at the following decisions :—

Considering the importance of the western and northern regions of Europe for the meteorological conditions of the northern hemisphere, and considering the importance that the investigation of the influence of the zone of the greatest intensity and frequency of the aurora borealis must have upon the character of the variations in the magnetic elements, the Conference proposes the establishment of fixed stations at the following points of the northern hemisphere :—

1. Spitzbergen.
2. Finmark (North Cape).
3. Nova Zembla.
4. Mouth of the Lena.
5. Point Barrow.
6. A point in the Archipelago of North America.
7. Upernavik (West Greenland).
8. Jan Mayen, or the east coast of Greenland.

11. The Conference further declared it to be its well-considered opinion that the occupation of the stations named at least was absolutely necessary for the complete solution of the problems in the domain of Meteorology and Terrestrial Magnetism.

12. In consideration of the importance of synchronous magnetic observations in the Arctic and Antarctic regions for the extension of our knowledge of the character of magnetic disturbances, and of systematic meteorological observations in high southern latitudes, the Conference is of opinion observing stations should, if practicable, be established and maintained for a definite period at the following places :—

1. Island of South Georgia.
2. Kerguelen Island.
3. Auckland or Campbell Island.
4. Balleny Island, if a landing is possible.

13. The Conference is of opinion that negotiations with the Government and the International Meteorological Committee, and the preliminary arrangements for carrying out the scheme of Polar exploration will be expedited by taking the observations in 1881, 1882, and that accordingly endeavours should be made that these observations should be begun in the northern hemisphere in the summer of 1881, and that they should be continued for at least a year.

14. With respect to the publication of the observations taken during the period in question, the Conference expresses its opinion in the following points :—

(*a.*) All the observations are to be published *in extenso* as soon as possible.

(*b.*) As it will be of importance that, for the synoptical investigations of the meteorological conditions during the period of observation, an abstract of the meteorological observations should be forthcoming as soon as possible, it should be urged, with the concurrence of the International Meteorological Committee, that at the latest *one* year after the termination of the observations, so far as this may be possible, the publication of such an abstract should be made, according to an uniform plan to be settled by the above-named Committee.

(*c.*) It is very desirable that the whole of the observations, wherever measures come into question, should be published in metric measures, and the temperature in degrees centigrade.

15. The Conference is of opinion that international participation, in addition to the Governments, Societies, &c., already represented at this Conference is indispensable to the success of the enterprise, and hopes that the proximate convening of a second and more generally attended Conference, after this preliminary one, will meet with success, and setting out from this point of view, it adopts the following resolutions :—

(*a.*) The promotion of the matter with the different Governments, Societies, &c., must be taken up energetically and without delay.

(*b.*) The Conference should declare itself to be a permanent International Polar Commission, until the solution of the problems for which it has been assembled, and should constitute itself as such immediately, by the election of a President, in order to have a central point for the direction of business and the promotion of the scheme.

(*c.*) The Conference desires that the International Polar Commission should be increased by the addition of delegates from other countries which have not been represented at this meeting.

(*d.*) The report and protocols of the proceedings of this Conference should be brought to the knowledge of the International Meteorological Committee without delay, with a request for their energetic support in the accomplishment of the resolutions adopted.

16. In order to obtain, by the carrying out of a common plan detailed in Part II., as complete contributions as possible for the solution of the meteorological and magnetical questions over the whole globe, the International Meteorological Committee is requested :—

(*a.*) To have the comparison of instruments, recommended by the Congress of Rome, especially that of barometers, carried out as soon as possible.

(*b.*) To take care, in good time, that not only the activity of the meteorological and magnetical stations already existing should be as comprehensive as possible, and extended in individual details during the periods of observation, but also that temporary stations should be established wherever a good connection between the proposed Arctic and Antarctic observing stations, and the actually existing stations in the temperate zones does not exist.

(*c.*) To exert its influence that the magnetic observatories upon the continents also should take more frequent observations upon the term days fixed by the programme of actual work, and at least at the special hours defined (as per protocols not printed here).

(*d.*) To exert its influence, that all over the globe, and especially in higher latitudes, as many self-recording instruments as possible be employed during this period, and that a certain selection of stations of the second order take observations several times a day, at equidistant and synchronous epochs.

(*e.*) To exert its influence that the Navies and Mercantile Marines of the different maritime nations should take part during the same period in the observations named under (*d*).

II. Special Part containing details respecting Observations, Instruments, and Epochs.

The Compulsory Observations in the Domain of Meteorology.

17. *Temperature of the Air.*—Mercurial thermometers graduated to 0°·2 C., and spirit thermometers graduated to whole degrees and verified at the Central Offices to 0°·1 C. are to be used.

18. The exposure is to be according to M. Wild's instructions, 1·5 to 2·0 metres above the ground, and in a double screen, furnished with louvres. The outer screen is to be made of wood, and the inner one of metal. The reading of the minimum thermometers may be effected in various ways.

19. The spirit thermometer must be compared with the standard mercurial thermometer, at the place of observation, at the lowest temperature attainable.

20. *The Temperature of the Seawater*, wherever possible, is to be observed at the surface, and at the depth of every 10 metres. The following instruments are mentioned incidentally as useful :—

Thermometers: Ekmann, Negretti and Zambra, Miller-Casella, Jansen, &c.

21. The freezing point of all the thermometers used is to be determined from time to time.

22. *Air pressure.*—At each station at least two good verified mercurial barometers, a spare barometer, and aneroids must be provided.

23. The principal barometer should be verified at least once a day.

24. *Humidity.*—Dry and wet bulb thermometers and hair hygrometers,

with Regnault's apparatus as a check, are to be used, according to M. Wild's instructions.

25. *Wind.*—The wind vane and Robinson's anemometer to be read off in the house (see the construction of the Swedish apparatus at Spitzbergen). Simultaneous estimation by Beaufort's scale to 16 points, direction by true bearings.

26. In order to decide the question whether cups with large or small diameters are to be recommended for determining the force of wind in Polar regions, it is desirable that preliminary experiments should be made before using such instruments.

27. *Form and Amount of Clouds.*—The motion of the strata at different heights should be observed to 16 points of the compass.

28. *Precipitation.*—Occurrence and duration of rain, snow, graupel (soft hail), and, where possible, the amount, the determination of which is compulsory only in summer, should be noted.

29. *Weather.*—Thunderstorms, hail, fog, hoar frost, and the optical phenomena of the atmosphere are to be indicated.

Compulsory Observations in the Domain of Terrestrial Magnetism.

30. *Absolute determinations.*—For the Declination and Dip an accuracy of one minute, and for Horizontal Force, 0·001 is to be aimed at; among the instruments may be mentioned, for instance, the portable theodolite of Lamont and ordinary dip instruments.

31. The absolute observations must be carried on in close connexion with and synchronous with the readings of the variation instruments, in order to enable one to reduce the indications of the latter to an absolute normal value, and to determine the zero points of the different scales. The determination must be carried out frequently, to enable the changes in the absolute values of the zero-point of the scales of the variation-apparatus to be accurately checked thereby.

32. *Observations of Variation.*—These should include all three elements and should be made by means of instruments with small needles (the opposite to the Gauss apparatus). For the purpose of an uninterrupted mutual control it is desirable to have two complete sets of variation-instruments which is further to be recommended in order to avoid an interruption of the observations from breakage or derangement of the instruments.

33. The horizontal force, in one of the sets at least, should be observed by the unifilar apparatus. Owing to the great disturbances to be observed, the scales of the variation-instruments must have a range of at least 10°, and arrangements must be made to obtain a simultaneity of readings as far as possible.

34. The variation instruments must be read from hour to hour, during the whole period. It is desirable that two readings at intervals of a few minutes should be made, for instance, before and after the complete hour.

35. With reference to this resolution, M. Weyprecht presented the following separate request:—

Separate request.—"As hourly readings, not made at precisely definite instants of time, appear to me to be insufficient, to determine in those regions of almost incessant disturbances such periods and mean values as express the character of the disturbance of the place and of the epochs sufficiently accurately for comparison, and considering the small increase of work which would be caused by repeated readings at definite instants of time. I cannot agree with the opinion of the majority of the Conference.

"I declare that in any case the Expedition to be conducted by me will read all three variation instruments hourly at—

"—h. 58m., —h. 59m., —h. 60m., —h. 61m., —h. 62m., Göttingen Time.

"Weyprecht."

36. The first and fifteenth of each month were fixed as term-days, reckoned from midnight to midnight, Göttingen Mean Time. The readings are to be taken every five minutes, at the completion of the full minutes, and the three elements are to be observed as quickly as possible after each other in the following order: horizontal force, declination, vertical force.

37. At such term-days magnetic observations are to be included in the plan of work, and are to be taken continuously, for instance, each 20 seconds during a full hour, even if they be for one element only. In the opinion of the Conference it would be most convenient to begin an observation so that one of the hours of observation may fall on the first hour of the first of January, and should be so continued through the period of observation that at each succeeding fortnightly term-day another hour is chosen for this purpose.

38. The exactitude of the magnetic observations is to be given in minutes for the declination, and to the fourth decimal place for horizontal and vertical force.

39. On the term-days continuous observations of the aurora borealis are also to be made. In addition the aurora is also to be observed from hour to hour, both as regards form and approximate position as to height and true azimuth bearings. The intensity of the light is to be estimated according to four grades.

40. The individual phenomena of the aurora are also to be made the subject of precise observation, and the different phases are to be noted, together with the simultaneous readings of the magnetic variation instruments.

41. As the greatest possible synchronism in the readings should be aimed at, determinations of place and time should be made with instruments fixed at the stations (Altazimuth instrument, and Transit instrument) which should not, however, prevent the use of good reflecting instruments. Every effort must be used to obtain as quickly as possible a suitable determination of position (especially longitude).

Special Observations.

42. The Conference earnestly recommends the following observations and researches to the attention of all those entrusted with the preparation of instructions for an expedition, or who are called to take part in one of the expeditions.

43. *Meteorological.*—The decrease of temperature with height, earth temperature, the temperature of snow and ice at different depths are to be determined.

44. *Observations of solar radiation* should be made, as well as those of *spontaneous evaporation.* The latter should be determined in winter by weighing cubes of ice, and in summer by means of atmometers.

45. *Magnetical.*—Absolutely synchronous readings from time to time of all three elements of terrestrial magnetism, with a view to the exact determination of the relation between the simultaneous variations of horizontal and vertical force.

46. *Earth currents.*—Observations of Earth currents in close connection with the magnetic observations and the phenomena of aurora borealis.

47. *Hydrographic investigations.*—Observations of currents, and the motion of ice—both as to direction and force.

48. *Deep-sea soundings,* and observations on the *physical properties of sea water, e.g.*, determination of temperature, specific gravity, gaseous contents, &c., and with this object the ships employed in the expeditions should especially be kept in view. Wherever possible tidal observations should be made by self-registering apparatus.

49. *Parallax of Polar light.*—Determinations of the height of the aurora borealis by measurements (for instance with the meteorographs (*sic*)), which should be made by detached observation parties, taking when possible simultaneous observations of the variations of declination.

50. Observation on atmospheric electricity, on astronomical and terrestrial refraction, on the length of a simple seconds pendulum, on the formation and growth of floating ice and glaciers. Collection of specimens of air for analysis. Observations and collections in the domain of Zoology, Botany, Geology, &c.

After the Conference at its Fifth meeting had discussed further details as to the carrying out of the observations during the proposed Polar expeditions, and had given up the idea of communicating them, or of formulating them, as definite resolutions in the present stage, it proceeded to constitute the International Polar Commission by the election of a President.

M. Neumayer was unanimously elected President of the Commission, with the idea that it would thereby be possible to proceed immediately to the execution of the individual resolutions, in so far as this initiative lay with the Commission, and could naturally belong to it.

At the Sixth meeting of the Conference the protocols of all the meetings, including the last, were confirmed, and the President then declared the Conference to be closed.

Buys Ballot.
Hoffmeyer.
Lenz.
Mascart.
Mohn.
Neumayer.
von Schleinitz.
Weyprecht.
Wykander.

Members of the International Polar Conference,
Hamburg, 6th October 1879.

APPENDIX IV.

Sir, Hamburg, 23rd July 1880.

In compliance with the request of the International Meteorological Committee, published in the *Zeitschrift für Meteorologie*, p. 278, I venture to submit the following proposal to the Committee, and earnestly to recommend its adoption, believing that it deals with a very essential defect in the method of notation and publication of the observations at present pursued. The more precise reasons for this proposal have been stated by me in an article now in the hands of Dr. Hann, and will be printed in the *Zeitschrift*. Dr. Hann has kindly undertaken to communicate this argument to the Committee, either in print or verbally.

The proposals contained under heads, 1° and 2° are in direct connection with each other, as the carrying out of the first is the preliminary condition for the adoption of the second. A third point, in which an improvement of the notation of hydrometeors appears desirable, although not so urgent, is the publication of a revised list of international symbols; as those published in the protocols of the Vienna Congress and of the Utrecht Conference exhibit many imperfections which are, I believe, of an accidental nature, rather than of principle. It would lead me too far to set forth in detail the objections against the individual symbols; the accompanying list appears to me however, as regards the illustration of the object:—elegance, and facility of drawing (*e.g.*, $\frac{\prime}{\prime}$ instead of $<$) to offer considerable advantages, and yet does not differ in all points more from the two mentioned, than the different styles of writing an alphabet do, and there is no fear therefore of misunderstanding; with the exception perhaps of the addition of the symbols for thunder (instead of thunderstorm), and for squalls, about the desirability of which you will probably agree with me.

As, however, I hold these alterations to be more a question of taste and convenience, than a real need of science, and as I consider them more as a matter of detail for the publishing Meteorological Institutions, I content myself with drawing your attention to them, and have not included them in the proposals which I made to the Committee.

Yours respectfully,
Dr. W. Köppen.

R. H. Scott, Esq.

● Rain.
✳ Snow.
△ Soft-Hail ("Graupel").
▲ Hail.
≋ Mist, Fog.
⌓ Dew.
⌊ Hoar-frost.
⊕ Solar Corona.
⊖ Lunar Corona.
☽ Lunar Halo.
○ Solar Halo.
V Silver-thaw ("Rauh-frost," "Duft").
~ Glazed Frost ("Glatteis").
✳→ Snow-drift.
→ Ice Crystals.
↯ Lightning.
T Thunder.
Strong wind.
• Rain Squalls (*a*.)
⌒ Rainbow.
Ш Aurora.
∞ Dust Haze ("Höhenrauch").

(*a*.) In the same way, by putting the proper symbol below the slanting arrow, squalls of another kind may be denoted, *e.g.*, ✳ snow squalls, △ soft-hail squalls, • thunderstorm squalls.

Proposal for a Reform of the Notation and Publication of Observations of Rainfall, &c.

1°. It is necessary in the interest of climatology, as well as of synoptical meteorology, that precaution should be taken by suitable alterations in the forms for observation and in the instructions for observers, as well as in the form of publication, for the unequivocal record of the hydrometeors existing at the moment of observation (especially rain, snow, hail, and soft hail). In publication this can be effected, by making the columns for the record of cloud observations wider, so that the above signs, together with the exponents 0 and 2 may be able to take a place next to the figure for cloud, if at the time of observation one of the specified hydrometeors existed (in the event of want of space, the most important would suffice). The observer's remarks, the detailed publication of which is very desirable, can be given with advantage, according to Kupffer's method, and as now done in the Annals of the Austrian Central Office, at the side of the tables, where they are not cramped for room.

With regard to the term "the moment of observation," each observation takes altogether a certain time, the observer can only be directed to make a fixed rule for the rotation in which the individual meteorological elements are to be observed, and to refer the estimation of the amount of cloud, together with the statement whether it rains, snows, &c., to a definite specified limit of time. The expression "Rain in showers," which is very suitable for the remarks because very characteristic, which is denoted by "*p*" in the Beaufort scale, is therefore of course to be entirely avoided in the notation of the weather at the moment of observation, as well as the likewise indefinite expression "rainy." These remarks refer, so far as regards the original day-books and instructions, to observers at sea as well as to those at fixed stations.

2°. It is desirable to introduce as a new element into meteorological summaries for land and sea, an expression for the "duration of rain" or for the "absolute probability of rain," in one of the three forms :—

$$\frac{r}{n}, \quad \frac{r}{n}\,N., \text{ or } \frac{r\,N}{n\,d},$$

in which n is the total number of times of observation.
r. the number of times of observation with rain.
N. the total number of hours in the period under consideration (Month).
d. the number of days on which rainfall is noted.

Therefore $\frac{r}{n}$ = the "absolute probability of rain."

$\frac{r}{n}N$ = the probable total continuance of rain in hours in the period under consideration.

$\frac{r}{n}\frac{N}{d}$ = the average duration of the rain upon a wet day.

Dr. W. Köppen.

APPENDIX V.

Det Danske Meteorologiske Institut,
Copenhagen, 11th May 1880.

In a treatise upon the storms of the Atlantic Ocean, copies of which I have had the honour to send to your honourable Committee, I have endeavoured to demonstrate how it would be possible to remedy, to a certain extent, the disadvantage of the situation in which the European meteorological service is placed, owing to our continent being bounded on the west by the ocean; and I have indicated, as a practical means, the establishment of meteorological stations on the Färoe Islands, Iceland, Greenland, and the Azores, in telegraphic communication with Europe.

I leave your honourable Committee judges of the value of this demonstration, but if it were required to show a conclusive proof of it, I would venture to draw attention to the fact that in pronouncing in this sense upon the scheme, the Committee would not only succeed in impressing upon it a seal of authority which my name alone is far from being able to give to it, but that it might become a powerful support, in bringing the scheme to a practical result.

In recommending this matter to your Honourable Committee, I cannot omit adding that I hold myself constantly at their disposal to furnish such information on this subject as might appear necessary or desirable.

N. Hoffmeyer,
Director of the Danish Meteorological Institute.

To the International Meteorological Committee.

APPENDIX VI.

Det Danske Meteorologiske Institut,
Copenhagen, 22nd May 1880.

In order to draw up the meteorological summaries of each day, and to judge of the importance of the atmospheric conditions, as well as their probable consequences, it would be very convenient to have some information, as reliable as possible, on the mean values and extremes of the elements of the weather at the stations which serve as a basis for the *international* and telegraphic meteorological service. The best thing would evidently be to know these data for rather short periods, for instance for pentades or decades, but the means and extremes even for each month would be of great assistance.

In the event of your honourable Committee sharing this view, I would venture to request it to take care that the materials necessary for this end were published in a convenient form, either by each individual country, for those stations for which the telegraphic reports relating to the weather are sent abroad, or, perhaps still better, by means of centralisation in one of the meteorological institutions; and in accordance with communications received from the other meteorological establishments.

N. Hoffmeyer.

To the International Meteorological Committee.

APPENDIX VII.

Berlin, 20th January 1880.

With reference to the preparation of a meteorological bibliography (§ 9 of the Programme), the Second International Meteorological Congress at Rome proposed the selection of the printed catalogues of the libraries of the Brussels Observatory and of the Meteorological Society of London as a starting point, and that each Central Meteorological Office should add the titles of those works which were not already contained in those catalogues; but, with respect to the second part, containing meteorological memoirs, that the work undertaken by Professor Cleveland Abbe should serve as a basis. The communications made to be by some meteorologists who have paid special attention to this question, as well as my own researches on this subject, have induced me respectfully to submit a few detailed proposals to the International Meteorological Committee.

1°. Catalogue of separate meteorological works.

On a close examination of the above-mentioned Brussels and London Catalogues, one is easily convinced that it is not practicable to select them as a starting point, as they are already methodically arranged. Assuming that the Central Meteorological Offices possess either a card-catalogue arranged according to names of authors, on a methodically classified catalogue, or merely a register of books received, or, lastly, only a position catalogue, it would in all four cases be equally tedious to pick out those works which were not contained in the printed catalogues in question, especially so in those many works which, owing to their manifold contents, would naturally be quoted several times. This procedure would only be rational when the printed catalogue, which was to serve as a basis, was arranged strictly alphabetically according to authors. Hence it appears to me best to give up entirely all reference to those catalogues, and to request from each central office simply a copy of its manuscript catalogue, however it may be arranged. The combination of all titles received, after the duplicates have been examined and struck out, taken in connection with the material contained in the published catalogues of Brussels and London, and any other material which may be available would furnish a tolerably complete catalogue of separate meteorological works. In addition to these contributions of individual institutions, an examination should be made of all those published catalogues which, although not specially devoted to Meteorology, contain works in the domain of this science. I have endeavoured to acquaint myself with the condition of the literature in question, and can say that at least about 40 such catalogues exist. General bibliographical works, second-hand catalogues, &c., which are mostly issued by booksellers, are also of the greatest use for such a work, especially in those issued by German-speaking countries, where the book trade has been carried on so methodically for a long time, the titles of all works containing Meteorology, which have appeared in the trade, are very easily accessible.

It appears to me, finally, that it would be a great guarantee for the completeness of the proposed work if the surprisingly extensive manuscript catalogue, which Mr. J. Symons, of London, has compiled in 24 folio volumes, were utilized in the preparation of the catalogue. I have myself inspected this work during a stay in London, and can say that I know of nothing more complete in this subject. Mr. Symons has expressed his willingness, in a letter to me of which a copy is annexed, to place the material which he has collected at the disposal of the Committee, on condition that it would defray the cost of extracting the titles of the meteorological works. If we assume that the expense of copying 100 titles, including the price of cards, would cost 4*s.*, the Central Office at Vienna, of which the library, according to a communication from Dr. Hann, numbers about 3,600 meteorological works, would have to make an outlay of about 7*l.* for this purpose; and this sum would be generally proportional for the

other institutions. I estimate the cost of the extraction of Mr. Symons' catalogue at about 15*l.*, which would have to be borne in common. With respect to the preparation of the raw material, I shall only remark that here also uniformity in the work is a principal condition of success. All titles must be copied on to cards of the same size, say like the one annexed, which Professor Cleveland Abbe has used, and according to correct bibliographical principles : (1) surname of the author; (2) initials of christian names; (3) exact titles of the work ; (4) what edition ; (5) place of publication ; (6) year of publication (of the edition in question) ; (7) numbers of volumes, parts, &c. ; (8) size of the work. The titles of works in the following languages : French, Italian, Spanish, Portuguese, Roumanian, German, English, Dutch, Danish, Norwegian, Swedish, need only be given in their original language, but works written in any other but the above languages must also be translated into (say) French.

2°. Catalogue of Meteorological memoirs, &c.

With regard to the second portion of the proposed bibliography, containing meteorological articles which have appeared in journals and periodical proceedings of learned societies, &c., I beg in the first place to draw attention to the annexed copy of a letter from Professor Cleveland Abbe, who has at the present time (*Zeitschrift der oesterreichischen Gesellschaft für Meteorologie*, Feb. 1879) already used the Royal Society's Catalogue as a basis of this work, as I had proposed to do. If then Professor Cleveland Abbe's work were used as a starting point—and there appears to be no reason against it, especially as he himself so willingly places it at our disposal—he would have to be paid the cost of copying, amounting to about 90*l.* Professor Abbe estimates the number of titles extracted from the first six volumes of the Catalogue in question at about 23,000. In the meantime the 7th and 8th volumes of this *Catalogue of Scientific Papers*, embracing the period from 1864 to 1873, have appeared, so that the cost of extraction of these volumes has to be added. As, however, in the preparation of this work all smaller notices and remarks, which often contain important communications, as well as all articles which contain in the main only observations, without discussions of any length, have been systematically omitted, all periodical papers specially devoted to Meteorology must be searched afresh in this respect, in the same way that MM. Houzeau and Lancaster have done with astronomical journals in the preparation of their excellent classified Bibliography of Astronomy. I have endeavoured to find out all the journals which are either wholly devoted to Meteorology, or in connexion with a kindred science, and they number 33, some of which, however, only existed for a few years and have long since ceased. This number will, no doubt, surprise many persons.

It is evident that notwithstanding the defects of the Catalogue of Scientific Papers it must serve as a basis of the work, if we consider, on the one hand, how meteorological articles, especially in the past, are to be found dispersed through all possible journals, of geography, medicine, statistics, and agriculture, and when we know, on the other hand, how great and manifold the number of papers extracted for that catalogue is.

For this second part of the bibliography we further possess valuable preliminary works in the bibliographical publications of some Academies, of which I would especially mention those of St. Petersburg, Berlin, and Brussels (in addition to the Royal Society).

The last and most difficult question of the scheme appears to me to be this—if the material is collected as completely as possible, who would examine, arrange and get it printed ; and out of what funds should the costs incurred be defrayed ? Should, say, one Central Institution perform this task, while a second, third, &c. should undertake the carrying out of other works of an international character ?

I do not venture to express any opinion on this matter here, but think I have shown in the foregoing remarks, that by a closer examination of the question how the materials for the preparation of a meteorological bibliography are to be obtained, so many points of detail crop up to be settled, that it appears to me that the International Meteoro-

logical Committee will not be able to discuss them thoroughly at its meetings, if it has the same character as the former Permanent Committee. If, however, any good result is to be arrived at in this direction, it will not be possible for the Committee to do otherwise than appoint a Special Commission for this question, either restricting itself to its own members, or obtaining advice from specialists outside its own body. In the same way a Committee of the British Association for the Advancement of Science some years ago prepared a valuable report upon a similar subject—The Bibliography of Mathematical Tables.*

A careful study of the preceding question has led me to this conclusion, and as author of the proposal which the Congress at Rome favourably received, I feel it my duty to draw the attention of the International Meteorological Committee appointed by that Congress to the matter.

GUSTAV HELLMAN.

R. H. Scott, Esq., F.R.S.,
Secretary International Meteorological Committee.

62, Camden Square, London, N.W.,
July 25th, 1879.

DEAR SIR,

I AM quite ready to do all that I can to assist. My catalogue, as you know, is the result of nearly 20 years' search, and is I believe the fullest in existence, as regards separate works and reprinted articles.

It is arranged strictly alphabetically under author's names, the plan which I think best for a universal catalogue.

It contains Astronomy, Climatology, Magnetism, and Meteorology.

I think that the course to be adopted would be for me to go through the volumes and mark all works coming under the heads of Meteorology and Climate, and then let my own copyists take out all these titles on stiff paper and send them to whoever prepares the catalogue. Although this involves taking out some hundreds of titles which are already in (say) the Brussels catalogue, I believe that it would be both safer and cheaper than trying to select titles not yet published.

The slip titles, whence the catalogue of the Meteorological Society was compiled, are still preserved, and could be lent for a few months without much inconvenience.

I think if these two sets were incorporated and put in type, proofs might be sent to each Central Meteorological Institute with a request that all additions should be written on stiff paper slips of a specified size. These additions being collected and inserted, your catalogue would be complete.

In conclusion, I have only to state that although it would be quite reasonable for me to ask some pecuniary return for the time I have devoted to the compilation of my own catalogue, I do not do so. I leave that entirely to the decision of the Permanent Committee; but as I hold no Government appointment, receive no salary whatever, and have to pay for all copying, it will be necessary to arrange for defraying its cost. I cannot tell the amount, but probably the best plan would be a specified sum for each hundred titles. I do not at all know the number of meteorological entries, but the entire catalogue fills 24 folio volumes.

G. J. SYMONS.

Herrn Dr. G. Hellmann.

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* Published in the Report for 1873.

Specimen of Card.

HERSCHEL, (*Sir*) *John Frederick William*. Report of a Committee appointed for the purpose of superintending the scientific co-operation of the British Association in the system of Simultaneous Observations in Terrestrial Magnetism and Meteorology.—Brit. Assoc. Rep. 1841, pp. 38-41.

DEAR SIR, Washington, August 22nd, 1879.

YOUR letter of the 6th was received to-day, and I will reply that I shall be very glad to assist in your Bibliography of Meteorology so far as I may be able.

In 1874 or 1875 I was officially assured that the Royal Society of London did not contemplate publishing an index by subjects as promised in the introduction to the first volume of the "Royal Society Catalogue of Scientific Papers." I therefore at once began a systematic examination of every title in this latter catalogue, affixing a mark to each one that in any way related to Meteorology and its application to other sciences or arts.

I have thus examined every title in the first six volumes, and an amanuensis whom I employed for this purpose has copied the titles upon cards of uniform size, as specimens of which I enclose a few that were rejected for some defect. Numerous errors of printing, &c. were corrected in the course of this work. The seventh volume I have as yet only

partially examined and have not begun to copy. I have estimated that my total outlay upon this work has, thus far, amounted to about 450 dollars (90*l.* sterling). The cards are arranged alphabetically in the order in which they are copied. My intention has been to further examine and copy in similar manner the titles given in the 7th and 8th volumes of the Royal Society Catalogue, and then to consult numerous other summary information, beginning with Poggendorff (Bib. Lit. Handwörterbuch), and Reuss (Commentationes), etc. etc.

This card catalogue was originally intended only for my own personal use, but if the "Permanent Committee" or yourself personally will repay me the expenses that I have incurred, and will undertake to complete and publish the bibliographical work, giving me some credit for what I have done, then I will transfer to you, or the Committee, all of my cards as a nucleus for your further work.

CLEVELAND ABBE.

Herrn Dr. Gustav Hellmann.

Berlin, July 20th, 1880.

In continuation of my communication of the 20th January last addressed to the International Meteorological Committee as to the possibility of the preparation of a general meteorological bibliography, as proposed at the Congress of Rome, I now venture to make a few further remarks, intended to throw light upon the purely practical side of the question, which is at present the most important. In doing this I omit entirely all reference to the third portion of the work, the Catalogue of Meteorological Observations hitherto taken, because this must be prepared by the Central Offices themselves, and because no accurate account of the extent and cost of the same can be obtained at the commencement.

The natural starting point of the following calculation of expenses is an estimate as reliable as may be of the extent of the projected bibliography, including both separate works as well as articles and notices. I start, therefore, with the published Brussels' Catalogue, as the most copious of the special catalogues in question, and with the new bibliographical work which MM. Houzeau and Lancaster are compiling, of the Bibliography of Astronomy.

The Brussels' Catalogue contains about 1,500 titles in Meteorology and Terrestrial Magnetism, of which, however, scarcely the half (700) are of separate works. If we assume, then, that in reality eight or nine times more such works exist, we obtain an aggregate, in round numbers, of

60,000 titles

of separate published works.

The probable number of titles of articles and notices I calculate from analogy of the collection which MM. Houzeau and Lancaster have obtained from the Royal Society Catalogue and from scientific journals for the above-mentioned Bibliography of Astronomy. The Royal Society Catalogue produced 16,000 titles, the examination of scientific journals gave 14,000 more, making 30,000 titles altogether. If we assume, then, that Astronomy, as the elder sister of Meteorology, must possess a much more abundant literature than the latter, we may take an aggregate, in round numbers of

25,000 titles

of meteorological articles as not being too low.* On the whole, therefore, we could reckon on 31,000 titles, or to take too high rather than too low a figure, say

32,000 titles.

As the proposed bibliographical work should receive a convenient lexicon-octavo form, there might be on one page (two columns to a page) 25 titles, together with occasional small bibliographical notices, and about

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* If Professor Cleveland Abbe has extracted about 23,000 titles from the Royal Society Catalogue alone, this was owing to a too wide limitation of the domain (partially including pure physics, &c. &c.)

400 titles conveniently brought into one sheet, so that the whole work would take 80 sheets,

viz. :— 1st Part (separate works) say 25 sheets
2nd Part (articles and notices) say 55 sheets.

I am indebted to some of the leading publishers and printers in Leipzig and Berlin for the following technical account of the preparation of such a work :—

Per sheet = 16 pages = 32 columns ; edition of 500 copies.

	£	s.	d.
For setting up - - -	4	10	0
For press-work and printing -	0	12	0
For paper - - - -	0	13	0
Total - -	5	15	0

For every additional 100 copies, *i.e.*, reprint, 3*s.* 6*d.* for printing and paper should be added.

These prices would, however, be much *increased* if the manuscript were illegible, and consequently many corrections necessary, or if subsequent insertions were made. If we do not take both extreme cases and reckon the unavoidable cost of correction at only 20% of the above sum, the printing per sheet would cost :—

£ s. d.
6 18 0
7 13 0 } for an edition of { 500 / 1,000 } copies.

In the event of the latter case, viz., an edition of 1,000 copies—and such a work would retain its value for centuries—the technical cost of preparation would be, for

	£
Setting up, printing, and paper -	632
Bookbinders' work - - -	15
Title, and binding in boards - -	10
Total - -	657

It is much more difficult and uncertain to estimate approximately the cost of the preparation of the manuscript for the press. In the following attempt at such an estimate, I make in the first place the two preliminary conditions :—

1°. That the preparation of the work, after the principles have been internationally agreed upon, shall be entrusted to one or several competent persons.

2°. That the individual Central Offices will do their utmost to furnish the raw materials gratis.

The best thing appears to me to take an actually printed title as the unit for the calculation of the cost, and to estimate the cost of compilation at

31 centimes (say 3*d.*) per title,

assuming that a portion of the editorship (the last revision and critical supervision) is done without cost, or at least at a cost not corresponding to the trouble and labour of such an arduous undertaking as the preparation of any general bibliography.

If we assume that the extraction of the Royal Society's Catalogue can be purchased from Professor Cleveland Abbe for 90*l.*, and that the extraction of Mr. Symons' manuscript catalogue could be bought for, say 15*l.*, and that the acquirement of other appropriate catalogues, &c., would cost 30*l.*, the whole cost of compilation might be reckoned as follows :—

	£
Compilation of 32,000 titles - - -	400
Professor Cleveland Abbe's catalogue -	90
Mr. Symons' catalogue - - -	15
Purchase of other catalogues, &c. - -	30
Total - -	535

The aggregate cost of a bibliography, 80 sheets thick, and an edition of 1,000 copies, would consequently amount to—

	£
Cost of technical production - -	657
Cost of editorship - - -	535
Total - -	£1,192

That this result of our calculation of, in round numbers, 1,200*l.* would be approximately correct, is shown by the comparison with the cost of the bibliography of Astronomy, which, according to the kind communication of the authors, amounted to 1,000*l.*, in which, however, scarcely any cost for editorship is included, as MM. Houzeau and Lancaster, respectively Director and Librarian of the Royal Observatory of Brussels, were not specially paid; otherwise, the expense would not have amounted to less than 1,400*l.*

On the ground of the foregoing discussion, we thus arrive at the conclusion that the possibility of the production of a general Meteorological bibliography is dependent upon the fulfilment of the following three conditions:—

1°. That the Central Meteorological Offices should furnish a copy of the catalogues of their libraries or of certain portions of them, free of cost.

2°. That a competent person should undertake the superintendence of the whole, according to principles to be agreed upon internationally.

3°. That the sum of 1,200*l.* should be collected by international contributions, by subscriptions, or by other means.

The possibility of success will depend essentially on the third point—the money question. I will make a few further remarks upon this point.

The sale of the Meteorological Bibliography would naturally be relatively small; with the exception of scientific institutions and scientific men, we can only reckon upon the larger public libraries as purchasers; and even if the International Meteorological Committee should use all its influence in the collection of a number of subscriptions, at the best scarcely 250 subscribers would be found. It may serve as a comparison that only 150 persons subscribed for the Bibliography of Astronomy. If then the work were sold at 2*l.* 10*s.* per copy, 250 copies would only fetch 625*l.*, or not one half of the actual expense, for perhaps 20 per cent. of the receipts would, in this case (subscription) fall to the commission agent, who for the remaining copies sold in the book trade would, as usual, take fully 50 per cent. of the published price. Therefore, only in the most favourable case, of the remaining 750 copies being sold in the trade, and a real income of $\frac{1}{2} \times 750 \times 50s. = 937l.$ 10*s.* being made, would the total cost be fully covered.

It will be seen that this is *impossible for the present*; all requirements, for the time being, would be satisfied by the sale of say 250 copies, and it is only on account of the bibliography having a lasting value, and in the course of years losing little of its saleability, that it might happen that after 50 years, or more, the whole edition of 1,000 copies would be exhausted. Therefore the plan of subscriptions cannot lead to the desired end, because the cost of the work must be covered at once, and there only remains the possibility of obtaining the funds by international means, if the preparation of the work is not undertaken by an individual country, as has been done by Belgium for the Bibliography of Astronomy in such a very creditable manner.

If, for instance, 30 bodies cover the cost by contributions of 40*l.* each, for which they would receive a certain number of copies gratis, a portion of the outlay might, in some years be refunded to them, so that they would have to bear, say, only the half of the actual expense, viz. 20*l.* We might even assume the favourable case, that the whole edition of 1,000 copies would be sold, and that the contributors might make a profit of, say 9*l.*, viz.:—

Six free copies representing a value of 15*l.*

If the net gain of the sale of the remaining copies reaches
$\frac{1}{2} \times 820 \times 50s. = 1{,}025l.$

	£	s.	d.
for distribution among the 30 copies, each would receive	34	3	0
in addition to the value of the free copies - -	15	0	0
	£49	3	0
The expenses being - - - -	40	0	0
Leaving the gain - - - -	£9	3	0

This method of procedure would, therefore, not be unlike shareholding. Without wishing to speak of an actual gain, I wish to show by this example that the expenses for individual bodies would, in fact, not be so great as might appear at first sight.

G. Hellmann.

APPENDIX VIII.

Replies to the Circular as to the carrying out of the Resolutions of the Congress of Rome.

Circular.

International Meteorological Committtee,
St. Petersburg and London, 30th October 1880.

Sir,

In the sixth sitting of its meeting at Berne the Committee read through the resolutions of the International Congress of Meteorologists at Rome, a resumé of which will be found in Appendix XI. of the Report of Proceedings of that Congress. From the information which the members of the Committee gave verbally on this occasion respecting the carrying out of these resolutions in their countries, the Committee decided that it would be useful to publish these data in the Appendix to the protocols of its meeting, and resolved to request all the directors of meteorological systems to furnish similar information to the Committee. In this way the Appendix in question would give a more complete idea of what had been done generally in carrying out the decisions and the wishes of the Congress of Rome.

You are requested therefore to be good enough to communicate as soon as possible to Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London) the remarks which you have to make respecting the carrying out of the resolutions of the Congress of Rome in your country.

Accept, &c.
(Signed) H. Wild, President,
R. H. Scott, Secretary,
For the International Meterological Committee.

Analysis of the Replies to the preceding Circular.

Replies have been received from the following gentlemen:—

Austria	Vienna	Dr. J. Hann.
Baden	Carlsruhe	Dr. Sohncke.
Denmark	Copenhagen	Capt. Hoffmeyer.
France	Paris	Prof. Mascart.
Germany	Berlin	Dr. Hellmann.
,,	Hamburg	Dr. Neumayer.
Great Britain and Ireland	London	Mr. R. H. Scott.
Holland	Utrecht	Prof. Buys Ballot.
Hungary	Buda-Pesth	Dr. Schenzl.
Italy	Pavia	Prof. Cantoni.
Norway	Christiania	Prof. Mohn.

Portugal -	- Lisbon - -	- Capt. de-Brito-Capello.
Russia - -	- St. Petersburg	- Prof. Wild.
Saxony - -	- Leipzig -	- Prof. Bruhns.
Spain - -	- Madrid -	- Senr. Aguilar.
Switzerland -	- Zürich - -	- Dr. Billwiller.
Würtemberg -	- Stuttgart -	- Prof. Schoder.

For Denmark and Spain respectively Capt. Hoffmeyer and M. Aguilar state that they carry out their operations in conformity with the resolutions of the Congress of Rome. In all other cases the special replies will be found under the heads of the different countries, arranged in alphabetical order, but only with reference to such resolutions as call for such replies.

Resolution 4.

"The Congress proposes that each country be invited to establish at a certain number of points, regard being paid to local conditions, stations at which continuous observations should be made by means of self-recording instruments, or else hourly observations during several term-days in each month, or lastly continued, equidistant, and frequent observations (eight times a day at least), in order to obtain the necessary data for reducing to true means the means of observations made twice or thrice a day at ordinary stations."

AUSTRIA.—Cracow, Fiume, Klagenfurt, Kremsmünster, Lesina, Pola, Prague, and Trieste are supplied with self-recording instruments. The mountain stations of Obir and the Skhafberg have only barographs.

BADEN.—There are no stations of the first order.

BELGIUM.—Continuous observations have been made by means of self-recording instruments at Brussels for the last 40 years. Automatic apparatus on von Rysselberghe's principle will be shortly erected at Ostend, Arlon, and Maeseyck; that is at the three corners of the kingdom.

FRANCE.—There are several stations which comply with the requirements of this question; *e.g.*, Parc St. Maur, Lyons, Clermont Ferrand, St. Martin de Hinx, &c.

GERMANY.—Berlin. Two-hourly observations of temperature and wind are taken at the Powder Magazine at Mecklenburg Schwerin, and will be published from January 1880.

GERMANY.—Hamburg. In the system of the Deutsche Seewarte, and therefore on the coast of Germany, the following stations are designated as normal observing stations of the first order:—

1. Memel.	Barograph and anemograph, and all the other instruments.	
2. Neufahrwasser.	Do.	do.
3. Swinemünde.	Do.	do.
4. Wustrow.	Do.	do.
5. Kiel.	Do.	do. and a thermograph.

6. Hamburg. A double series of self-recording instruments, and all other instruments.

7. Sylt. Barograph and anemograph, as Memel, &c.

8. Wilhelmshafen.	Do.	do.
9. Borkum.	Do.	do.

It is proposed to publish the results of the self-recording apparatus in tabular form: 1878 will soon be ready, and contains the results from four stations only; 1879 will have five or six.

10. Leipzig is a station of the first order.

11. Munich has self-recording apparatus of old pattern, but without an anemometer.

12. At individual observatories (astronomical) there are barographs and thermographs, and at some places anemometers in connexion with automatic tide gauges.

13. Kaiserslautern. A station of the first order has been established this year.

14. Magdeburg. A station, with self-recording apparatus, is the property of the publisher of the "Magdeburger Zeitung."

15. At Frankfort-on-the-Maine the Physical Association has established an observing station, with barograph, thermograph, and anemograph.

GREAT BRITAIN AND IRELAND.—In addition to the seven observatories in connexion with the Meteorological Office,—Aberdeen, Armagh, Falmouth, Glasgow, Kew, Stonyhurst, and Valencia,—the observatories of Greenwich and Oxford (the Radcliffe Observatory) possess complete outfits of self-recording apparatus.

In addition, the Bidston Observatory (Liverpool), and that of the Earl of Crawford at Dunecht, possess barographs. And there are numerous anemographs on the coast.

HOLLAND.—At Utrecht, pressure, temperature, and magnetic declination, as well as the force and direction of wind, are recorded continuously on the Cathedral tower, at the height of 328 feet, and at the Central Institute; at Helder and at Groningen, the pressure, temperature, and force and direction of wind are recorded hourly; at Flushing pressure and wind force and direction hourly.

HUNGARY.—The values deduced by Jelinek for some localities in Hungary have been hitherto used as corrections for barometrical and thermometrical readings. No stations of the first order have as yet been established in the country, nor could hourly observations be carried out. At the Central Office there are many years records of barographs and thermographs still unreduced.

ITALY.—There are three stations of the first order: Milan, Naples, and Rome.

NORWAY.—There are no stations of the first order, nor any meteorographs. The Director, however, hopes to obtain funds for providing such.

PORTUGAL.—Two observatories, Lisbon and Coimbra, are furnished with self-recording instruments for the principal meteorological elements. These suffice for the deduction of the meteorological elements for the coast stations, which are not at a great elevation above the sea level.

SAXONY.—There is one station provided with self-recording apparatus. It seems needless to supply such to other places owing to the limited area of the kingdom.

SWITZERLAND.—Self-recording instruments, recording every 10 minutes the state of the meteorological elements, are erected at Berne. At Geneva and on the Great St. Bernard readings are taken at two-hourly intervals from 6 a.m. to 10 p.m. In the reduction of the individual means corrections from a long series of observations at Geneva and on the St. Bernard (by interpolation by means of Bessel's formula) are applied, but at present for temperature only.

Resolution 5.

"The Congress recommends the general adoption of the forms of publication already introduced in several countries for observations at a certain number of stations of the second order chosen in each country as international stations. (See the Reports of the Committee for 1873 and 1874, p. 9, third meeting at Utrecht, and Appendix F.)

"The monthly and yearly resumés published by the central offices for the different stations contain, in accordance with the resolutions of the Congress of Vienna, a summary of the frequency of the eight principal directions of the wind, both for the months and for the year. Seeing the importance which must be attached, not only to the direction but also to the *force of the wind*, the Congress proposes (in accordance with M. Weihrauch's proposal) to publish also in these summaries the *mean force* of each wind, and for the greatest possible number of stations for each month and for the year. Where the form adopted allows sufficient space, the figures representing the frequency and the mean force should be placed side by side: otherwise it is preferable to give both in the form of an appendix.

"The observation of the direction of the upper clouds, and especially of cirrus, at some stations of each country, and the publication of these observations in the form of an appendix, is strongly recommended, and

also the publication of observations on the temperature of the surface of the ground. (Question 18.)"

BADEN.—The annual reports for Carlsruhe have for years contained the monthly and yearly means of wind force for the stations of the Grand Duchy of Baden.

BELGIUM.—The observations are published in conformity with the international form of publication.

FRANCE.—The form recommended has been adopted since 1878; the observations are given in detail for 22 stations, of which 12 are in France and 10 in Algeria; in addition, monthly resumés are published for 71 French and 36 Algerian stations. Charts are published showing for each month, and for the year, the prevalent direction of wind, the distribution of pressure, mean temperature, and rain in France and adjacent countries. The documents are preceded by a climatological review.

GERMANY.—Berlin. In the general publication of the Meteorological Institute of Germany (exclusive of Bavaria), the "Meteorologische "Beobachtungen in Deutschland angestellt auf 17 Stationen "zweiter Ordnung," the observations of five Prussian stations are published in extenso, on the international form.

Since 1879 the international form has been adopted for the month and yearly resumés.

Cirrus observations for some stations have been included for the year 1880.

GREAT BRITAIN AND IRELAND.—Returns have been published on the international form for the year 1878, for 25 stations in detail, and for eight additional stations, in the form of monthly abstracts.

The stations are in connexion partly with the Meteorological Office, and partly with the Meteorological Society (London).

The observations are taken at 9 a.m. and 9 p.m., local time.

HOLLAND.—At Utrecht the components of each wind are calculated, those winds being combined which are in the same quadrant.

HUNGARY.—The mean monthly and annual wind force will be published from the year 1880 in the Jahrbücher of this Institute, from the stations of the second order, in the form required by the Congress.

Underground temperatures are at present observed at only one station (Hódmezö Vásárhely). At the central observatory (Buda-Pesth) thermometers have been plunged to the depth of one metre, but observations have not yet been commenced.

PORTUGAL.—Since January 1880 the monthly observations of all the continental stations, of those in the Azores and in Madeira, and of two stations in Africa, St. Thomas and San Paolo de Loanda (14 in all) are published on the international plan. Previously only the stations we call international were so published.

RUSSIA.—The international form of publication has been introduced since 1874.

With the year 1880 the calculation of the mean force of each wind has been taken up again for our stations, and will be published in due time in the annals.

In the year 1880 most stations have been provided with thermometers for the observation of the temperature of the earth's surface, or that the results of the observations can be published in future, together with those of the motion of the clouds, in the appendix to the annals.

SAXONY.—At Leipzig and Dresden. Robinson's anemometers are erected, and the indications of wind force obtained from them will be included in our publications. At other stations where it is difficult to find suitable exposure for anemometers it is only possible to estimate the direction and force of the wind, the latter on Beaufort's scale. It is only for Leipzig and Dresden that the velocity corresponding to each direction of the wind can be given in metres per second.

The direction of the clouds is observed at Leipzig, and will in future be included in the publications.

Switzerland.—The form of publication referred to has been introduced for a limited number of our stations (11–15) since February 1874. With reference to the summary of wind observations, it is to be remarked that owing to the configuration of our country, these are of such a local nature that it would be of comparatively little use to draw up the resumés in monthly or yearly tables, without any explanatory text. It would appear more suitable for this country to exhibit the wind observations in close connexion with an explanation of the conditions of the land, which could best be done in separate treatises.

Resolution 6.

"The Congress recommends the general adoption of the code of figures for meteorological telegrams proposed by the Permanent Committee of the Vienna Congress at its fourth meeting at Utrecht."

Belgium.—The code is in use.

France.—The code is in use.

Great Britain and Ireland.—The code is in use.

Portugal.—The reports from Madeira and Lisbon are sent to Paris, according to the code adopted by the Congress of Rome. We receive, in addition, reports from eight French stations and from the observatories of Madrid and San Fernando on the same code.

Russia.—The international code has been adopted for many years.

Switzerland.—With a few modifications the general code has been adopted. The changes have been determined by the limited extent of our system, and are chiefly contractions.

Resolution 9.

"The directors of the different meteorological systems are invited to prepare catalogues of the published and unpublished observations in their respective countries, and to inform the International Committee of the work already done in that direction."

Baden.—The list of the printed and MS. series of meteorological observations, memoirs, and works has been published in the Seventh Annual Report of the Central Station, Carlsruhe, for 1875, which appeared in 1877.

Belgium.—The observatory of Brussels will soon undertake the preparation of all the observations made in the country which are either in print or in MS. At the same time it will prepare a second edition, considerably enlarged, of the catalogue of its library.

Great Britain and Ireland.—A list of all the works published by the Meteorological Office appears on the cover of every publication.

Holland.—Prof. Buys Ballot has prepared a list.

Hungary.—A list of the meteorological observations made prior to the establishment of the Central Meteorological Office will be shortly prepared.

Portugal.—A catalogue of all the publications of this observatory, including the observations made at various stations, has been recently made and will be published shortly.

We shall also compile a catalogue of meteorological works and memoirs, although these may be of slight importance.

Saxony.—A list of all series of observations made in Saxony, both published and unpublished, will be compiled and published shortly.

A list of the books in the library which are not found in the catalogues of the Meteorological Society or of the Brussels Observatory will be prepared.

Switzerland.—Several old series of observations have been published in the Schweizerische Meteorologische Beobachtungen (see p. xv. 1877). A catalogue, as complete as possible, of all the published and unpublished observations is in preparation.

Resolution 10.

"The Congress recommends the directors of all central institutions to have their instruments compared with the standard instruments of other countries."

Baden.—Prof. Sohncke says, "I have made a fresh comparison of the "Carlsruhe barometer (on Fortin's principle) with the standard baro-

" meter of the Zürich Observatory, in August 1880. The result will " be published in the Annual Report of my office for 1880."

Belgium.—The barometer and a standard thermometer belonging to the observatory were compared with the standards of Kew Observatory.

Holland.—Our normal barometer has been compared by Prof. Dove, subsequently by M. Rikatcheff, and in 1875 with the barometer of the Deutsche Seewarte by Dr. Neumayer. We possess also two barometers verified at Kew which are 0·5 mm. lower, and a French barometer by M. Ernst. We have also two thermometers verified at Kew, as well as one by Fastré and one by Baudin.

Hungary.—The Central Office is not in a position to undertake a comparison of the standard instruments, and must defer it until it has an observatory of its own.

Switzerland.—We are quite ready to compare our standard instruments with those of neighbouring countries, and think we can commence it in 1881.

Resolution 13.

"The Congress considers the following subjects as possessing a general interest:—

(*a.*) Critical collection and discussion of all existing data on the diurnal range of air temperatue, and attempts to deduce general laws therefrom.

(*b.*) Critical collection and discussion of all existing data on the diurnal and annual range of absolute and relative atmospheric humidity, and attempts to deduce general laws therefrom.

(*c.*) Critical collection and discussion of all data on the diurnal and annual range of the state of the sky, that is, of the amount of cloud.

(*d.*) Wind tables for the 12 months and for the year.

(*e.*) Tables of precipitation for the 12 months and for the year.

(*f.*) New tables of atmospheric pressure, with isobars, for the 12 months and for the year.

(*g.*) Charts of the movements of storm.

(*h.*) Daily synoptic charts embracing considerable portions of the globe.

The directors of central institutions are invited to have these works executed as soon as possible for the stations of their respective countries and published, in order that they may serve as a basis for researches which may be undertaken on the general march of meteorological phenomena over the surface of the globe."

Belgium.—Both MM. Quetelet, father and son, have published several memoirs on the march of temperature at Brussels.

M. Lancaster published last year a paper on thunderstorms in Belgium.

France.—The observations of thunderstorms are summarised and published each year, with charts of the march of the principal storms. The observations of rainfall, published *in extenso* each year for more than 1,100 stations, are further summarised for seasons and for the year; they are accompanied by a notice on the system of the rainfall, and by charts showing the distribution of the amounts of water for each season and for the whole year. Lastly, one volume of the *Annales du Bureau Central* is specially devoted to articles on general meteorology.

Holland.—For Utrecht and some other stations the required tables are given in several publications.

Portugal.—We have already published a resumé of the meteorology of Portugal and also another very detailed investigation into the barometer and thermometer readings during the 20 years, 1855–75. This memorandum will be revised as soon as possible for the barometer, thermometer, and hygrometer for the years 1855–80.

Russia.—A critical discussion of the daily and yearly range of temperature for Russia has been carried out by Dr. Wild. A similar inquiry

for rainfall has just been undertaken in the Central Physical Observatory.

Switzerland.—The investigations here mentioned are indicated in the programme of the Central Meteorological Office, which will soon be enlarged, and be established as a Government office. Hitherto, *i.e.*, as long as the Institute was maintained by the Natural History Society, and only subsidised by the State, the sphere of its action was very limited, consisting chiefly in the collection of observations.

Resolution 15.

"(1.) The reduction of barometer readings to the sea level by the addition of a constant quantity during the whole year is only admissible for heights not exceeding 20 metres, if we wish to obtain an accuracy of $\pm 0{\cdot}5$ mm. ($\pm 0{\cdot}002$ in.). Consequently, for stations situated at a height exceeding 20 metres, account must be taken of the temperature and approximately of the relative humidity, according to Laplace's method.

"(2.) In weather reports it is desirable that the barometric readings unreduced should be given by the side of the readings reduced to the sea level; in other publications it is *necessary* to have in all cases unreduced readings.

"(3.) It is desirable that the International Meteorological Committee should undertake the compilation of fresh uniform tables for the reduction of barometric readings to the level of the sea.

"(4.) It is equally desirable that the Committee should undertake the preparation of a collection of tables which may be employed in the meteorological systems of the different countries."

Belgium.—The reduction of the barometer to sea level is made in conformity with the recommendations of the Congress.

Holland.—Having demonstrated theoretically in the Jaarboeker and practically by the deviations (écarts) that reduction to sea level for considerable heights is unsafe, I reject all reductions for the stations on table lands and on mountains, and practically admit it only for Maestricht (height 54 metres.)

Hungary.—The reduction of the barometer readings to sea level for all stations except Fiume is done by Laplace's method. The calculation of the vapour tension and the relative humidity is effected by Dr. Wild's tables.

Russia.—In the daily bulletin of the Central Physical Observatory the unreduced barometer readings are always given by the side of those reduced to sea level.

Switzerland.—Points 1 and 2 are fulfilled.

Resolution 16.

"The Congress is of opinion that the method indicated in M. Pernet's report on the determination of the fixed points of thermometers should be provisionally accepted."

Russia.—The fixed points of the thermometers have been determined in the Central Observatory according to the rules laid down by M. Pernet.

Switzerland—We shall endeavour to carry out this resolution soon.

Resolution 17.

"The Congress, without actually prescribing a fixed form of thermometer screen suitable for different climates, and even for the exigencies of observers, draws the attention of meteorologists to the reports and communications presented to the Congress, either as printed papers, or in the protocols of the meetings of the Committee."

Belgium.—Hitherto we have used Stevenson's screens, but lately Renou's screen's have been erected with double roofs and without louvres We shall shortly commence comparative observations.

Saxony.—Three stations of the third order have been provided with double zinc screens, for the protection of thermometers, of the pattern referred to by Dr. Wild and myself. The other stations have in part simple zinc screens, in part sheltering boards over the top, so that the temperatures observed may correspond as closely as possible to the conditions of nature.

Resolution 18.

"The Congress has not been informed of any new experiments made on the subject of Earth Temperature since the date of the Vienna Congress, and in conformity with M. Wild's suggestion, proposes to admit the temperature of the surface of the earth among the meteorological elements to be observed at stations of the second order."

BADEN.—Earth temperatures not observed.

FRANCE.—Observations relative to the temperature of the earth at different depths have been made for 20 years at the Museum of Natural History of Paris, by MM. Becquerel; they are continued, and are regularly published. Three or four new stations are in course of organisation.

GERMANY.—Berlin. From the year 1881 the temperature of the soil will be observed at a few selected and suitable stations.

GREAT BRITAIN AND IRELAND.—Earth temperatures not observed at the stations in connexion with the Meteorological Office. Observations are taken at Greenwich and Edinburgh, and at some of the stations of the Scottish Meteorological Society.

HOLLAND.—Earth temperatures not observed.

HUNGARY.—Observations of earth temperature are not carried on at all the stations of the second order. I shall, however, endeavour to have such experiments made at some of the forest stations.

PORTUGAL.—We have made during the whole of the year 1879 daily observations of underground temperature at depths of 1·5, 1·1, 0·7, 0·3, and 0·05 metres, by means of Becquerel's electric thermometers. Since January 1880 we have taken observations at depths of 10 and 5 metres in addition to the others, and we have also made direct observations at the same depths as those enumerated above, with Lamont's earth thermometer, in order to compare the results of the two methods, direct and electrical.

RUSSIA.—See remarks under No. 5.

SAXONY.—Earth temperature observations have been made at 12 stations during a series of years, mostly with a set of eight thermometers at depths of 0·1, 0·25, 0·50, 0·75, 1·00, 1·50, 2·00, and 3·00 metres. The observations are published in the volumes of the results of Saxon stations.

SWITZERLAND.—We expect to have observations of earth temperature made on the surface and beneath at the agricultural and forest stations which will soon be established in the country.

Resolution 19.

"The Congress finds that the researches into the subject of radiation are not yet sufficiently advanced to enable it to propose a method of observation, and considers that the question should be referred to the next Congress."

FRANCE.—The bright sunshine will be regularly observed from 1881 at a dozen stations, by means of the special apparatus known as the sunshine recorder.

GREAT BRITAIN AND IRELAND.—Sunshine recorders of the pattern devised by Prof. Stokes have been supplied to about 30 stations, and the results, which give the duration of bright sunshine, are published in the Weekly Weather Report.

PORTUGAL.—Since January 1877 we have observed M. Marié Davy's actinometer four times daily. The results are published in the Annals of the observatory.

Resolution 20.

"The Congress recommends the employment, as far as may be possible, of a regular arrangement for ventilation in the determination of the humidity of the air by means of the dry and wet bulb thermometers."

BADEN.—We have no arrangement for ventilating the wet bulb thermometer.

HOLLAND.—Ventilation is considered very important. I made my propositions about it in 1872, and ordered a hygrometer provided with an arrangement to ensure a current of air. This, however, is not so good as that which I saw at Berne and which I shall adopt.

Russia.—At the observatories of Pawlowsk and St. Petersburg the air in the thermometer screen has since the beginning of 1880 been always set in motion by means of a ventilator, in making direct hygrometric observations with the dry and wet bulb hygrometer. The velocity of the motion of the air by this means is about 2 metres per second. It is intended to introduce this ventilation gradually at the other observatories, and stations also, as an investigation into this matter made by Dr. Swarikin at the Central Observatory, which will shortly be published in the Repertorium, has definitely shown that the dry and wet bulb hygrometer, with the addition of a ventilator, becomes a very trustworthy instrument for hygrometric observations.

Saxony.—Ventilation is not employed in the observation of the wet bulb thermometer, the method of moistening the thermometer shortly before observing and of waiting until it has reached its lowest point has proved the best here, better than the method of keeping it constantly damp by the capillary action of a cotton wick, &c.

Switzerland.—We have not yet introduced the ventilation for the dry and wet bulb thermometers, but will recommend its adoption to the Meteorological Commission.

Resolution 21.

"The Congress points out that atmometers generally should fulfil certain conditions of comparability, and expresses the opinion that there is need of fresh researches being undertaken, for the determination of the form and exposure of the instruments to be employed."

Holland.—Few things are of such importance as the study of evaporation I have requested the engineers of the Waterstaat to make experiments on a large scale.

Portugal.—Since January 1880 we have every day observed Piche's atmometer placed by the side of, and at the same height as, the ordinary atmometer which has been observed at our stations in the country since 1863.

Russia.—Wild's balance atmometer has been introduced for some years at upwards of 20 stations, and is everywhere similarly exposed. The comparable evaporation observations thus obtained have been discussed in a memoir recently published in the Repertorium für Meteorologie, vol. viii., "Researches on the various forms and "exposure of atmometers as carried on at the Observatory of "Pawlowsk."

Norway.—During the Norwegian Arctic Expeditions of 1876-7-8, I have made experiments on the evaporation of sea water with a floating atmometer. A calculation by Weilenmann's formula, however, does not give at all a satisfactory accordance with the measured values of the depth of water evaporated. The same result has come out of a series of observations with the instrument made on board the Norwegian corvette, "Nordstjernen," on a voyage to the West Indies and back.

Resolution 22.

"The Congress thinks, that for stations of the second and third order, a diameter of 8 or even of 4 inches is sufficient for the rain gauge.

"As to the position of the rain gauges the Congress confines itself to recommending that they should never be placed upon a roof, but that they should be sufficiently elevated to be out of the influence of drifting snow, and of the splashing of drops from the ground, while they must not be sheltered by trees or other neighbouring objects."

France.—The rain gauges have an area of 3 or 4 square decimetres; they are generally exposed at about 2 metres above the ground.

Germany.—Berlin. The new rain gauges have an area of $\frac{1}{20}$ of a square metre.

Hungary.—The rain gauges distributed by the Central Office have an area of $\frac{1}{10}$ square foot, only a few stations are provided with gauges of $\frac{1}{20}$ square metre area. Excepting in a few towns where erection near the surface of the ground is impracticable the gauges are placed at a height of from 1 to 2 metres above the ground.

Russia.—At the Central Physical Observatory investigations have been continued into the most suitable exposure of rain gauges, especially with reference to the accurate measurement of snow, by avoiding both its blowing out of the receivers and its drifting into them. In both directions the enclosure of the rain gauge, standing 1 metre above the ground, by a wooden screen of 2·5 metres in height, and at a distance of 2 metres, has hitherto been found the most effective.

Switzerland.—These points are attended to as much as possible.

Resolution 23.

"The Congress does not feel itself prepared at present to reply to the question of the determination of wind velocity. It confines itself to recommending the directors of central institutions to effect a comparison between the anemometers employed in different countries."

Belgium.—For a long time the force of wind has been measured by means of an Osler's anemometer, which indicates, as is known, the pressure of the wind in kilogrammes. Since 1878 this instrument has been replaced by a Robinson's anemometer, which registers the velocity of the movement of the air. It was soon recognised that the indications of one of these instruments were not sufficient for the study of the various questions relative to the force of the wind, and it is proposed to observe both instruments, at the same time, when the new observatory is built.

Holland.—At more than one station the velocity of the wind is observed and registered. At Utrecht the observations are entered on the same schedule as the force of the wind, in order to provide a better comparison than we as yet possess, even better than the comparative observations of Professor Stamkart, who was not able to obtain the two classes of observations from the same spot.

Russia.—All meteorological stations in Russia are at least provided with Wild's pressure plate (the pendulum-anemometer), the indications of which are referred to the normal anemometer of the Central Observatory. Several observatories possess in addition a Robinson's anemometer which has been compared with this normal anemometer.

Resolution 23a.

"The observation of the direction of the upper clouds, and especially of cirrus, at some stations in each country, and the publication of these observations in the form of an appendix is strongly recommended."

France.—Cirrus clouds are regularly observed at Parc St. Maur.

Great Britain and Ireland.—Cirrus observations are recorded at a few stations, but no results have been published yet, except in some papers by the Rev. W. Clement Ley.

Portugal.—The observations of the motion of upper clouds have been made ever since 1877 at Lisbon and Campo Maior.

Saxony.—It has already been stated in the answers to question 5 that the proposal of Dr. Hildebrandsson for the observations of clouds is carried out at Leipzig.

Switzerland.—Cloud observations are carried on as completely as possible.

Resolution 25.

"The Congress is of opinion that the study of atmospheric electricity has made marked progress in recent years, and recommends that a comparison should be made between the instruments which are most generally used."

Belgium.—We are engaged in the erection of an apparatus permitting of the study of the distribution of atmospheric electricity of the successive strata of air in a vertical direction.

France.—Instruments are being erected at several observatories.

Portugal.—This observatory has purchased a portable Thomson's electrometer, in order to make comparison with the results of one of Branly's electrographs, which has been working ever since 1877 in one fixed position. In the latter instruments we have lately

adopted M. Mascart's system of insulation, which has considerably improved its indications.

Resolution 25a.

"After having heard with interest the Report of M. de Rossi on the phenomena, which he comprises under the term 'Endogenous Meteorology,' the Congress expresses a desire to see such researches continued, and insists upon the relations which may exist between them and those of general meteorology."

SWITZERLAND.—A special Seismometrical Commission appointed by the Natural History Society is charged with the collection and study of such data.

Resolution 30.

"A. The Congress, recognising the importance that observations made in balloons, especially at places situated in the interior of the continents, may have for the physical study of the higher regions of the atmosphere, recommends the taking of observations of temperature and humidity by means of captive balloons, and according to Glaisher's method, in strata at different heights, and on different days, and in different seasons. It recommends also the study, by means of captive balloons, of the diurnal range of temperature and humidity in the upper strata of the atmosphere and the detailed publication of these observations.

"B*a*. The Congress thinks that it would be very useful if observatories could possibly be established on the summits of mountains, and the observations published *in extenso*, so that that they may be placed at the disposal of all meteorologists, and may aid in the solution of problems which may present themselves in future.

"B*b*. The Congress insists upon the utility of a series of hourly observations of temperature, pressure, direction, and force of wind, and eventually also of humidity on Mount Washington, and especially at Pike's Peak, the highest station upon the earth. This series should embrace one year at least; and it would also be desirable to publish in detail the observations already existing for these two stations. General Myer is requested to be good enough to realise these desires of all meteorologists.

"B*c*. The Congress recommends the Swiss Society of Natural Sciences to do its utmost to promote the establishment of an observatory upon one of the high summits of Switzerland. It expresses the desire that meteorological stations may be established under similar conditions in Italy and other countries.

"B*d*. The Congress considers the establishment of the observatory of Etna, proposed by M. Tacchini, of that of Mont Cimone, proposed by M. Parenti, and that of Mont Ventoux, supported by the Meteorological Commission of the Department of Vaucluse, as enterprises of high scientific importance.

"C. The Congress requests the directors of the meteorological systems of the various countries to be good enough to publish in a complete manner the existing series of observations made at elevated stations, and which have either not yet been published, or only in an incomplete manner; and at the same time to indicate and describe the stations of their systems which might furnish materials for the study of the upper regions of the atmosphere."

AUSTRIA.—The observations on the Obir (Carinthia) 2,070 metres, and on the Schafberg, 1,776 metres, will be published *in extenso* in our Jahrbücher.

FRANCE.—The observations on the Puy de Dôme and the Pic du Midi are published.

GERMANY.—Berlin. In the course of this year two mountain stations of the second order have been established, the Schneekoppe (1,600 metres) and the Brocken (1,141 metres). These observations, as well as those of the corresponding stations on the plain below, Eichberg (348 metres) and Nordhausen (222 metres), are to be published *in extenso*.

A resumé of the old observations on the Brocken (1836–59 and 1866–7, with interruptions) will be published in the Report for 1880.

As a supplement to Dr. Hann's Report on the observations on high mountains and in balloons, it may be remarked that the results of 10 years summer observations (May to October) on the Schneekoppe are given in Galle's Grundzüge der Schlesischen Klimatologie (Breslau, 1854).

HUNGARY.—Observations at high stations are not made, as generally high stations with us are uninhabited. Arrangements have, however, been made to place minimum thermometers at some high points in the Carpathians.

ITALY.—The observatory on Mount Etna has been completed and is nearly ready for observations in physical astronomy (with a great refractor), in meteorology, and terrestrial physics. In that fine southern climate, an observatory so large and provided with so good instruments, at a height of 2,950 metres, cannot fail to give results of great interest to science.

The arrangements for the establishment of an observatory on Mont Cimone, in the Appennines of Modena, are going on, and promise to secure the realisation of the project.

At the high stations of the Stelvio and Valdobbio it is hoped to establish self-recording instruments.

SWITZERLAND.—The project of a mountain station in this country was recommended by the Meteorological Commission, and the Säntis peak, 2,504 metres high and very isolated, was indicated as the most suitable point for the purpose. The requisite funds are, however, not yet perfectly assured, but will be so as soon as the Central Meteorological Office has at its disposal the proposed increased grant, owing to its being raised to the position of a Government institute.

Resolution 30a.

"The Congress draws the attention of meteorologists to the importance of measuring the variations in length and thickness of the glaciers in the different countries in order to be able to deduce the relations which exist between these variations and those of the meteorological elements.

"As a means of extending our knowledge upon this question, the Congress recommends:—

"To form a complete critical collection of observations made in times past upon the variations of volume of the glaciers.

"To institute in future continued observations at localities suitably chosen, upon the annual variations of the glaciers in length and thickness and to publish the results.

"The Congress hopes to be able to rely upon the co-operation of the Alpine Clubs and other analagous societies in carrying out these researches."

AUSTRIA.—Professor Richter (Section Salzburg of the Deutsch-Oesterreichischen Alpen-Verein) has put up marks on the Tauern of the Karlinger glacier and measured the lower end of the glacier in order to be able to register its changes. He has also dealt with the Upper Salzbach glacier, of which he made an accurate survey. He has been able to prove that during the last 20 years this glacier has diminished one twentieth in area, and the tongue has gone back 410 metres, *i.e.*, one fortieth of its entire length (1,896 metres). The profiles which have often been constructed show very clearly the decrease in size of the glacier. It has lost from 40 to 110 metres in depth in the last 30 or 40 years.

Bergrath Seeland, of Klagenfurt, has put up marks on the Pasterze in order to detect the changes in length of this glacier.

SWITZERLAND.—The Natural History Society, as well as the Alpine Club, further the study of glacier movements in every way in their power.

Resolution 32.

"The Congress cannot give effect to the proposal of Mr. Parkinson, who has asked for funds for organising a meteorological service in the Samoa Islands, because it has no international fund at its disposal: but with

regard to the importance of this proposal, it expresses the hope that private initiative will permit of meteorological observations being taken in the Samoa Islands.

"The Congress considering—

"1°. That it is of the highest importance that the meteorological stations established by different countries in parts of the globe, which are very remote and difficult of access, may be visited from time to time, in order to ascertain the accuracy of the instruments and of the amount of confidence which can be placed in the observations;

"2°. That such an inspection may be most conveniently made by officers of the navies of the maritime powers,

Proposes to forward to the Governments of the countries represented at the Congress the request that they will kindly take the necessary steps that, on the one hand, the officers commanding vessels visiting those parts may receive instructions, in pursuance of which they would place themselves in communication with the observers at those meteorological stations, whatever be the nationality of the latter, for the purpose of comparing the instruments, and of acquainting themselves with the manner in which the observations are made; and on the other hand, that the observer charged with the care of the station may place himself at the disposal of the officer visiting it, whatever be the maritime power by which he is commissioned.

"The Congress recognises that the establishment of meteorological stations in Bulgaria, Roumania, and Servia would be of the highest importance, and it begs the Italian Government to cause this wish to be communicated to the Governments of those States."

GERMANY.—Hamburg. The German African Society in Berlin has sent out an expedition to Lake Tanganyika, where a station is to be maintained for two years. Although Dr. Kaiser reports from Zanzibar that one of the standard barometers is broken, he still hopes that he can organise the station satisfactorily with the instruments which are left. On the west coast of Africa a series of observations have been made by Herr Soyaure, at the factory of Herr Woermann of Hamburg. A good barometer by Fuess of Berlin has lately been tested at the Seewarte, and is now on its way to Africa.

There have been numerous instances of persons addressing themselves to the Seewarte, with reference to the establishment of observations in tropical regions. In every case, however, they have been informed that the Seewarte neither will, nor has the power to, undertake the management of such organisations.

GREAT BRITAIN AND IRELAND.—A complete outfit for a station of the second order was sent to Norfolk Island in 1878, and good observations have already been received.

A good barometer, compared at Kew, has also been sent out to Nain in Labrador, to the station maintained by the Moravian Brethren. Stations are maintained by the Meteorological Office at Bermuda, on Sombrero Island, at several lighthouses in the Bahamas, and at the Falkland Islands, but from the impossibility of inspecting regularly and effectually, the observations are not of much value.

Instruments have been sent out to Cyprus for six stations of the second order: Famagusta, Kyrenia, Larnaca, Limasol, Nicosia, and Papho.

GREECE.—From a letter addressed to Mr. Scott by Dr. Schmidt of Athens, it appears that there is but little prospect of meteorological observations from this country.

ITALY.—The Meteorological Commission is at present engaged in establishing a station in the Bay of Asab, near the Straits of Bab-el-Mandeb, and another at Alexandria, and it is intended to supply tested instruments and to send out capable observers.

JAPAN.—Mr. E. Knipping writes to Dr. Hann from Tokio, under date February 4, 1879: "The Imperial Meteorological Observatory of "Japan, which is admirably equipped, and at which five practised

" observers are employed, has published since June 1875 daily " observations, with five-day means and monthly tables, and " thereby renders my observations, if not entirely useless, yet of " less importance, so that my work does not stand in any proper " relation to the results now obtained. I have therefore deter- " mined to close my observations with 1879.

" By personal inquiry I have learnt that the observatory here " will enter into relations with all foreign central offices, so that " there will be no interruption in the returns you receive from this. " I can add the satisfactory information that an observatory has " been established at Nagasaki a year ago, and since January 1879 " another in Hiro-shima (on the Inland Sea). Several others in " Hiogo, Sendai, Hakodati, and Sappro (both in Yezo) will be " established in future."

Roumania.—M. Hepites makes careful observations at Ibraila which are published in the Jahrbuch of the Central Anstalt of Vienna.

Russia.—The Central Physical Observatory has received complete Meteorological Observations, made by Lieut. Tjägin with the first instruments delivered at Nova Zembla, from August 1878 to August 1879, and these will appear *in extenso* in the Annals for 1879.

South America.—Mr. H. B. Joyner (formerly of Tokio, Japan) has commenced observations at Sao Paulo.

Dr. Walz of Bogotá has written to Dr. Bruhns (under date April 22, 1880), to request assistance from the International Meteorological Committee for the establishment of a station at that place.

APPENDIX IX.

Report on the Meteorological Organisation of England in 1876,* being a Supplement to Appendix V. of the Report of the Second International Congress at Rome.

Question 1.—*How many stations are there in your system?*

(*a.*) *How many of the* 1*st order?*
(*b.*) ,, ,, 2*nd* ,,
(*c.*) ,, ,, 3*rd* ,,

70, [1] viz., *a* 7, *b* 44 (including 29 telegraphic reporting stations), and *c* 19. In addition the Observatories of Greenwich, the Radcliffe Observatory, Oxford, and the Bidston Observatory possess self-recording instruments: six stations in connexion with the Meteorological Office possess anemographs: the Meteorological Society numbers 16 stations of the second order, and the British Rainfall system counts as many as 2,000 observers.

The Scottish Meteorological Society also possesses an extensive organization.

[1] In 1879, the total number of stations of the second and third orders in the British Isles in connexion with the Office was 22 and 24 respectively, and of those in England and Ireland in connexion with the Meteorological Society was 23 and 48 respectively.

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* The constitution of the Office was changed in 1877, and consequently these answers require modification in several particulars in order to show the conditions in 1880. The most important of the modifications are given in the notes.

Question 2.—*Are these stations at which no self-recording instruments are used, but only eye observations made?*

(a.) If so, to what uses are the latter put?

At the stations of the first order, self-recording instruments are used. The monthly and five-day mean results for these stations for pressure and temperature are published in the Quarterly Weather Report.

The returns for the stations of the Second Order are published for climatological purposes, on the International scheme.

Question 3.—*What means are taken to ensure correctness at all the stations?*

Regular inspection almost every year, and constant close examination of the records.

Question 4.—*How often and at what hours are observations made?*

At the stations of the First Order six eye observations are made daily to control the automatic records. At those of the Second Order observations are made at 9 a.m. and 9 p.m. local time. At the Telegraphic stations observations are taken at 8 a.m., 2 p.m., and 6 p.m. Greenwich time, and at several of these stations the barometer is read at 10 p.m. also.

Question 5.—*How are the observations recorded? Who supplies the schedules?*

The observations are recorded in rough day books, and copied into monthly tables, all supplied by the Meteorological Office or the Society.

Question 5*a*.—*If supplied from the Central Office, is their cost defrayed from its own funds?*

The cost of printing is not defrayed out of the annual grant to the Meteorological Office.

See answer to question 17*a*.

Question 6.—*Are the observers paid? and if so, at what rate?*

The stations of the first order, the seven observatories, receive a regular annual allowance of about 250*l*. The observers at the stations of the second order are all volunteers. The Telegraphic reporters are paid about 13*l*. per annum.

Question 7.—*Who appoints the observers?*

The Telegraphic Reporters are the only observers appointed by the Meteorological Office, except in the case of the distant observatory of Valencia, which is managed from London, inasmuch as there is no local institution at that place with which it could be connected.

Question 8.—*Can they be changed?*

The Telegraphic Reporters can be changed. If any of the stations of the second order fail in accuracy the publication of their returns is discontinued.

Question 9.—*How often are the stations inspected?*

Almost without exception the stations are inspected every year.

Question 10.—*By what persons and at whose expense?*

The Director of the Office was in 1876 the sole inspector, but the observatories were also visited yearly by the Superintendent of the Central Observatory at Kew. (2)

The cost of inspection is borne by the Meteorological Office.

(2) Since 1877 separate inspectors have been appointed for the three kingdoms, the Secretary to the Meteorological Office inspecting Ireland. The stations in connexion with the Meteorological Society are inspected by its Assistant Secretary.

Question 11.—*Who supplies instruments?*

At the observatories and the Telegraph stations the instruments employed are the property of the Meteorological Office. At the stations of the second and third orders the instruments are the private property of the observers.

In the branch of Ocean Meteorology (Question 22) all the instruments employed in the Royal Navy, and by the observers in the Mercantile Marine (upwards of 100 in number) belong to the Meteorological Office.

Question 11*a*.—*Are they verified before or after erection?*

All the instruments belonging to the Office, and all those employed at stations connected with it, are verified originally at Kew Observatory.

Question 12.—*What staff is employed in the Central Office?*

A director, a marine superintendent, 5 senior, 6 junior, and 8 temporary clerks, 1 engraver, an office keeper, a commissionaire, and a porter. (3)

(3) In 1879 the staff of the Office consisted of 1 Secretary to the Council, 1 Marine Superintendent, 1 assistant in the Marine Department, 5 senior, 6 junior, and 19 temporary clerks, 1 engraver, 1 office keeper, 1 commissionaire, 3 boys, and 1 porter.

Question 12*a*.—*Have any of the staff any other sources of official income?*

No.

(4.) *Question* 12*b*.—*What are the usual office hours?*

10 a.m. to 4 p.m., except in the Telegraphic Department, where the attendance is from 8.30 a.m. to 9 p.m. (4)

(4) In 1878 the hours were altered to 9 to 5.

Question 12*c*.—*Is residence or any other special advantage enjoyed by the director or any of the staff?*

No.

Question 13.—*How is the work divided at the Central Office?*

I. Ocean Meteorology; II. Weather Telegraphy; and III. Land Meteorology; and IV., in addition, Administration and Correspondence.(5)

I. Meteorology employs the Marine Superintendent, 2 seniors, 1 junior, and 3 temporary clerks.

II. Weather Telegraphy employs 1 senior, 3 junior, and 2 temporary clerks.

III. Land Meteorology employs 1 senior, 1 junior, and 4 temporary clerks, with 1 engraver.

IV. The Administration employs 1 senior and 1 junior clerk, with the office keeper and commissionaire.

The last three branches are under the special management of the director.

(5) In 1879 the staff was increased under I. by 3, under II. by 4, under III. by 6, under IV. by 2.

Question 14.—*Who appoints the clerks?*

The Committee of the Royal Society, who manage the Office.(6)

(6) In 1877 the Office was transferred to a paid Council nominated by the Royal Society and appointed by the Government.

Question 15.—*What salaries are paid to the clerks and to the superintendent?*

The Director receives 800*l*. annually, the Marine Superintendent 400*l*.; the 5 senior clerks together 1,000*l*.; the 6 junior clerks together 566*l*.; the 8 temporary clerks 540*l*. 16*s*.; the engraver 109*l*. 4*s*.; the office keeper 100*l*. These payments to the clerks are exclusive of what can be earned at overtime.(7) (Ques. 16*b*.)

(7) These salaries in the case of the clerks have been altered, owing to the increase in the hours of attendance. The Council receive 1,000*l*. a year.

Question 16.—*Who pays these?*

The Committee, out of their grant from Government.

Question 16*a*.—*Are their appointments permanent, and is there any provision for superannuation?*

The appointments are not permanent, and there are no pensions.

Question 16*b*.—*Are there any extra allowances, e.g., for additional work or special services?*

The clerks are allowed to work at home at overtime, and those who attend at extra hours, as in the Telegraphic branch, and at the Reporting stations, receive extra pay.(8)

The funds for the Telegraphic extra pay are provided by the "Times" newspaper, for the use of which journal the arrangements are made.

(8) Overtime has been abolished, the hours of attendance having been increased. The arrangements with the "Times" were modified in 1880.

Question 17.—*What publications issue from the Central Office?*

The list of published books, &c. is printed on the cover of each publication of the Office.

In addition, lithographed Daily Weather Charts are issued to the number of about 500, more than half of which are distributed free.

The Hourly Readings of Pressure, Temperature (Dry and Wet thermometers), Wind (Direction and Velocity), and Rain at all the seven Observatories are also lithographed and distributed to the principal Meteorological Institutions.

Question 17*a*.—*From what fund is the printing paid?*

By Her Majesty's Stationery Office.

Question 17*b*.—*How many copies of your publications are distributed free?*

The number varies.
Of all publications there are distributed, 172 copies.
,, ,, except Marine publications, 65 copies.
Of Marine only, 134 copies.
Of smaller publications only, 22.

Question 17*c*.—*How many are sold?*

Very few.

Question 18.—*Are there daily observations published from any stations as well as average (weekly or monthly), and if so from how many stations?*

The automatic records from the seven Observatories are reproduced in full in the Quarterly Weather Report. In addition, the hourly readings of the instrumental curves are lithographed, as explained in Answer 17.

For the year 1876 the observations at 9 a.m. and 9 p.m. have been published for the stations of the second order on Form A, in detail, for 15 stations; on Form B, in abstract, for 14 additional stations. In addition, daily observations for 29 stations are published in the Daily Weather Reports.

Question 19.—*Is provision made for the discussion of particular points in reference to storms, weather, public health, agriculture, &c., or in reference to more scientific questions?*

Various investigations into the history of particular storms, &c. have been published by the Office from time to time.

Numerous papers on such subjects, prepared in the Office, have appeared in the Quarterly Journal of the Meteorological Society.

Question 20.—*Have any researches been carried on with a view to the improvement of instruments or methods of reducing observations?*

The Office has constantly directed its attention to the improvement of existing instruments, and methods of observation and reduction, in every branch of the science which comes under its sphere of action. The results are published in its Annual Reports.

Question 21.—*What is the cost of the Meteorological Department under all its different heads?* (1.) *For instruments.* (2.) *For stations.* (3.) *For observers.* (4.) *For cost of records.* (5.) *For transmission to Central Office.* (6.) *For verification of observations.* (7.) *For publication of results.* (8.) *For warnings of storms.* (9.) *For abstract physical and scientific results.*

The total expenditure of the Office in the year ending March 31, 1875, was 11,685*l.* 10*s.* 6*d.*

The Parliamentary vote was 10,000*l.*,(9) and the balance was received from various sources, such as the sale of instruments, subscriptions to the Daily Weather Reports, and the contribution from the "Times" newspaper for the evening Telegraphic Weather Service.

The amounts are distributed as follows:—

	1874–5.			1878–9.		
Office—	£	*s.*	*d.*	£	*s.*	*d.*
Salaries	1,314	19	0	2,512	10	8*
Rent, fuel, and furniture	603	2	8	576	8	7
Contingencies, printing, &c.	195	17	0	387	0	8
Special researches	—			270	3	11
Land Meteorology—						
Expenses at observatories	2,644	3	11	2,433	19	1
New instruments for do.†	391	12	9	51	9	6
Computations	763	11	2	1,361	19	0
Weather telegraphy	2,139	8	9	3,148	5	9
Inspections, D. W. Charts, &c.	583	2	3	292	18	1
Computations	665	6	8	1,266	4	4
Ocean Meteorology—						
Marine Superintendent	400	0	0	400	0	0
Admiralty instruments	265	15	0	353	11	0
Mercantile Marine do.‡	575	4	11	571	17	1
Computations, &c.	1,143	6	5	1,337	9	7
Total	£11,685	10	6	14,963	17	3

(9) In 1878 the Parliamentary grant was 14,500*l.*

Question 22.—*Does your Department deal with both Land and Ocean Meteorology?*

Yes, as already explained, and it supplies all the Meteorological Instruments used in the Royal Navy.

ROBERT H. SCOTT.

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* Including honorarium to Council.

† The purchases of instruments for colonial establishments, &c. are included under the heads of "New Instruments for Observatories" and of "Mercantile Marine instruments."

‡ Including Instruments and Agency Accounts (seaports).

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REPORT

OF

THE SECOND MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

Held at Copenhagen, August 1882.

Published by Authority of the Meteorological Council.

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REPORT

OF THE

Second Meeting of the International Meteorological Committee.

COPENHAGEN, AUGUST 1882.

Protocol of the First Meeting, 1st August 1882.

THE MEETING was opened in the "Hydrographic Office" at 10h. a.m.

Present: MM. Wild (President), Buys-Ballot, Hann, Mohn, Neumayer, and Mr. Scott (Secretary).

The PRESIDENT welcomed those members who were present, and stated that two members, viz., MM. de Brito-Capello and Mascart, had been prevented from reaching Copenhagen in time for the first Meeting, but that they would come as soon as possible, and would probably be present at the next meeting. He further stated that M. Cantoni had been prevented by illness in his family from attending the present meeting, and that he would at a later period lay before the Committee the correspondence which had passed with that gentleman, and which contained a proposal made by him.

The PRESIDENT proposed that M. Hoffmeyer, as the host of the Committee, should be invited to attend its meetings.

Mr. SCOTT drew the attention of the Committee to the Resolution of the First Meeting at Berne, in which the terms of admission of non-members were defined. He recommended the Committee not to establish a precedent which might produce inconvenience in future.

M. NEUMAYER agreed with Mr. Scott as to the latter reservation, but was of opinion that, in the present instance, in accordance with the President's proposal, the invitation of M. Hoffmeyer, as the host of the Committee on the present occasion, could not give rise to any inconvenient precedent.

It was accordingly resolved unanimously to invite M. Hoffmeyer to attend the present Meetings.

The PRESIDENT requested the Secretary to read the Programme of questions for discussion proposed by the Executive Officers.

The Programme was read and adopted with some additional articles, proposed respectively by MM. Hann, Neumayer, and Buys-Ballot. (Appendix I.)

The PRESIDENT requested the Secretary to read his Report Appendix II.), the first point of the business to be considered.

The Report was read and adopted.

It was resolved to have M. Houzeau's letter printed as Appendix XII. to the Report of the Committee.

The discussion was opened on M. Cantoni's proposal to resign his seat on the Committee in favour of M. Tacchini (Article XII. of the Programme). M. Cantoni's letters of the 3rd and 27th July (Appendix III.) were read. The Committee expressed its full concurrence with the President in his regret at M. Cantoni's resignation, as expressed in his reply to that gentleman, and in accordance with the proposal contained in M. Cantoni's letter of July 3, unanimously elected M. Tacchini a member of the Committee.

The discussion was opened on Article VII. of the Programme:—

"The proposed International collection of the systems of storm-warnings, &c. to the coasts of different countries, for the International Fisheries Exhibition in London, 1883."

The letter, dated 8th July, of Sir Brandreth Gibbs, Secretary of the "International Fisheries Exhibition," was read (Appendix IV.).

The Committee resolved, on the proposal of the President, to invite the Directors of Central Offices to send to the Meteorological Office, for the proposed Exhibition, a collection of apparatus and copies of all Instructions referring to the issuing of Weather Forecasts and Storm Warnings to the seafaring community, and also relating to Maritime Meteorology.

The discussion was opened on Article X. of the Programme :—

"Report on the degree of conformity with the decisions of the "Congresses of Vienna and of Rome of the instruments and "methods of observation actually in use."

The PRESIDENT proposed that fresh reports for each country should be asked for, and be printed separately in the Report of the Committee, and not be separated up into various heads, as before, in the case of the Report of the meeting at London.

This proposal was supported by Mr. Hann.

It was resolved that the reports should be asked for and printed, as suggested by M. Wild, the reports to have reference to the 31st December next. Any reports received too late to be published separately.

MM. Hann, Mohn, and Neumayer, were appointed a Sub-Committee to draw up a plan for the Report, and to submit it to the Committee at one of their subsequent meetings.

The Secretary submitted the Report of the Second Intercolonial Conference of Australasia, held at Melbourne the 21st–

27th April 1881. He was requested to have a summary of this Report printed as Appendix V.

The meeting was adjourned at 12h. 30m. p.m. until 2h. p.m.

A letter from M. Petyt, Vice-President of the Chamber of Commerce of Dunkirk, dated 29th July, was read, asking permission for M. Terquem to attend the meetings of the Committee, as the said Chamber takes a lively interest in the proposed cable to Iceland.

It was agreed to admit M. Terquem on the conditions laid down at Berne.

The discussion was opened on Question VIII. of the Programme (M. Köppen's proposal as to "the symbols for hydrometeors").

M. Hann stated that a French translation of M. Köppen's proposals had been sent to all the members of the Committee belonging to the Latin nations. (Resolution of the Third Meeting at Berne.)

With regard to the First proposal, for alteration of the international symbols, it was agreed, after discussion, not to alter the symbols recommended by the Congress of Vienna, with the exception of the introduction of notice of squalls, by inserting the symbol for "strong wind" beside that for the phenomenon, as "rain" or "snow."

The consideration of the Second proposal was then taken up.

"1°. It is necessary in the interest of climatology, as well as of synoptical meteorology, that precaution should be taken, by suitable alterations in the forms for observation and in the instructions for observers, as well as in the form of publication, for the unequivocal record of the hydrometeors existing at the moment of observation (especially rain, snow, hail, and soft hail). In publication this can be effected by making the columns for the record of cloud observations wider, so that the above signs, together with the exponents 0 and 2, may be able to take a place next to the figure for cloud, if at the time of observation one of the specified hydrometeors existed (in the event of want of space, the most important would suffice). The observer's remarks, the detailed publication of which is very desirable, can be given with advantage, according to Kupffer's method, and as now done in the Annals of the Austrian Central Office, at the side of the tables, where they are not cramped for room.

"With regard to the term 'the moment of observation,' each observation takes altogether a certain time, the observer can only be directed to make a fixed rule for the rotation in which the individual meteorological elements are to be observed, and to refer the estimation of the amount of cloud, together with the statement whether it rains, snows, &c., to a definite specified limit of time. The expression 'Rain in showers,' which is very suitable for the remarks because very characteristic, which is denoted by '*p*' in the Beaufort scale, is therefore of course to be entirely avoided in the notation of the weather at the moment of observa-

tion, as well as the likewise indefinite expression 'rainy.' These remarks refer, so far as regards the original day-books and instructions, to observers at sea as well as to those at fixed stations."

(*a*.) M. Mohn recommended the adoption of the system already introduced in the Norwegian Annals, for 1880 and subsequent years, viz., to employ the following exponents :—

a morning (between the first and second daily observation).
p evening ,, second and third ,,
n night ,, third and first ,,

Rain or other phenomena, observed at the exact time of any epoch of observation, to be indicated by a symbol entered after the record of the phenomenon which gives the epoch; for instance :—

●[1] Rain at 8h. a.m.
✳[3] Snow at 8h. p.m.

Rain or other phenomena, observed during the interval *between* the epochs of observation, to be indicated by exponents added to the symbols; for instance :

●[on] Light rain during the night.
●[na] Rain during the night, the morning, and at 8h. a.m.

M. Mohn's proposal was adopted.

" 2°. It is desirable to introduce as a new element into meteorological summaries for land and sea, an expression for the 'duration of rain' or for the 'absolute probability of rain,' in one of the three forms :—

$$\frac{r}{n} \quad \frac{r}{n} N. \text{ or } \frac{r\,N}{n\,d}$$

in which n is the total number of times of observation.
r the number of times of observation with rain.
N the total number of hours in the period under consideration (Month).
d the number of days on which rainfall is noted.

Therefore $\frac{r}{n}$ = the 'absolute probability of rain.'

$\frac{r}{n} N$ = the probable total continuance of rain in hours in the period under consideration.

$\frac{r\,N}{n\,d}$ = the average duration of the rain upon a wet day."

(*b*.) The Committee regretted that it could not recommend the adoption of M. Köppen's proposal as to the probability of rain, &c., because the data for these calculations are not given by observers at Stations of the Second Order, but it recommended observers at Stations of the First Order, and at sea, to consider the possibility of giving this information.

The discussion was opened on Question XVII. of the Programme :—

" The importance of the study of evaporation not only from a free water surface, but also from surfaces of different characters, as, for instance, of sand, of clay, &c."

The Committee, while recognizing the importance of these researches, was not of opinion that any resolution or recommendation, more precise than those existing, could be framed, as the observation of evaporation generally had not made sensible progress since the Congress at Rome.

M. Hoffmeyer submitted to the Committee a new rotary hygrometer which had been invented by himself and Captain Rung.

The sitting ended at 4h. p.m.

(Signed) H. Wild.

Protocol of the Second Meeting, Wednesday, 2nd August.

The Meeting was opened at 10h. a.m.

Present: MM. Wild (President), Buys-Ballot, de Brito-Capello, Hann, Mohn, Neumayer, and Mr. Scott (Secretary).

A telegram from M. Mascart was read, announcing that he expected to arrive before noon.

The protocol of the first meeting was read and confirmed.

The discussion was opened on Question XV. of the Programme:—

"The Members of the Committee are requested, if possible, to bring under the notice of meteorologists the results, at least for the period of the International Polar Stations, of observations of stations which do not belong to any meteorological system, and which appear either irregularly or in local publications, and are always difficult to procure. This is particularly desirable for stations situated in the intervals between the existing systems, especially in tropical regions."

After remarks on this subject by different members, it was agreed to issue a circular to the Directors of Central Offices to draw their attention to M. Hann's proposal, inviting them to communicate, for the *Bulletin International Polaire*, a list of distant stations from which observations might be obtained.

The discussion was opened on Question IX. of the Programme.

M. Hoffmeyer stated to the Committee that the Meteorological Office of London had already begun to publish, in the *Daily Weather Reports*, monthly means of Observations taken at Telegraphic Reporting Stations, commencing with the year 1880, as he had indicated in his proposition to the meeting at Berne.

The following was the action on M. Hoffmeyer's proposal at Berne:—

"In order to draw up the Meteorological Summaries of each day, and to judge of the importance of the atmospheric conditions, as well as their probable consequences, it would be very convenient to have some information, as reliable as possible, on the mean

values and extremes of the elements of the weather at the stations which serve as a basis for the international and telegraphic meteorological service. The best thing would evidently be to know these data for rather short periods, for instance, for pentades or decades, but the means and extremes even for each month would be of great assistance."

"In the event of your honorable Committee sharing this view, I would venture to request it to take care that the materials necessary for this end were published in a convenient form, either by each individual country, for those stations for which the telegraphic reports relating to the weather are sent abroad, or, perhaps still better, by means of centralisation in one of the Meteorological institutions; and in accordance with communications received from the other Meteorological establishments.

"The Committee adopted the following resolution :—

"The Committee has heard with interest Captain Hoffmeyer's communication, and recommends the Central Institutions to calculate the averages, &c. which he proposes, for the International and Telegraphic stations."

The Committee decided to recommend the Directors to add to their *Daily Weather Bulletins* at the end of each month the monthly means for Telegraphic Stations, according to the example of the Meteorological Office of London.

The discussion was opened on Question XIV. of the Programme :—

"Is it desirable that the number of members of the Committee should be increased, by the addition of certain persons representing other important Meteorological Organizations."

Several members of the Committee were of opinion that it might be desirable to increase the number of members. But it was found that, by the resolution of the Congress of Rome, the Committee was to consist of nine members only. This being a formal obstacle to the proposed augmentation, it was thought that a future Congress could alone make alterations in this direction.

M. Neumayer repeated on this occasion a communication which he had already made at Berne, namely, that he had been instructed by the German Government to announce that in the event of any proposal being made to convene a third Congress, that Government reserved its decision as to its participation therein, and that, speaking generally, the German Government was at present of opinion that it would not be desirable to convene a fresh Congress soon.

The meeting was adjourned at 12h. 30m. p.m. until 2h. p.m.

M. Mascart arrived in the meantime, and expressed his deep regret that he had not been able to reach Copenhagen sooner, and to take part in the first meeting, at which the question of the replacement of M. Cantoni by M. Tacchini was brought forward. He stated that he regretted the determination which M. Cantoni had taken, but that he would have readily acquiesced in the

opinion of the Committee in support of the nomination of M. Tacchini.

The discussion of Question XIV. was resumed, and finally M. Mascart proposed the following resolution: "While considering the extension of the International Committee to be desirable, it does not appear possible to give effect to that desire, on account of the conditions on which the nomination of the Committee by the Congress of Rome took place.' This resolution was adopted.

The discussion was opened on Question XVI. of the Programme:—

"A communication from MM. Hoffmeyer and Neumayer on the subject of the issue of daily synoptic charts and weather reports for the area of the North Atlantic Ocean, and the countries bordering on it."

On the invitation of the PRESIDENT, M. HOFFMEYER made the following communication to the Committee:—

"MM. Hoffmeyer and Neumayer submit to the Committee a plan for the publication of daily synoptic charts of the North Atlantic Ocean and its coasts.

"The plan differs from the analogous scheme which was submitted to the Congress at Rome in so far that the cost of the publication of the charts and explanatory text (*Synoptic Review*) is to be borne by the Danish Meteorological Institute and the *Deutsche Seewarte.*

"MM. Hoffmeyer and Neumayer communicate to the Committee this plan, which is to be considered only as a private agreement between the two institutions above named, with the object of requesting the various directors to kindly assist them with materials, and of eliciting an expression of opinion from the Committee upon the importance of the undertaking.

"The Committee is requested, however, to understand that it is not a question of a resolution of a general nature, but that the gentlemen named hope to be provided by the Committee with a resolution worded in such a way as to indicate the importance of daily synoptic charts for the development of theoretical meteorology and of the practical study of weather. They propose to submit copies of such a resolution, if adopted, to their respective Governments as a justification for the expense of the proposed publication, which will amount to a considerable sum.

The Committee adopted the following resolution:—

"The Committee considers that such a continuation of Captain Hoffmeyer's synoptic charts, as may be anticipated from the proposal of MM. Hoffmeyer and Neumayer, will be of the greatest importance for the progress of dynamical meteorology, and that the publication of daily charts for an extensive area is indispensable for researches into general meteorology and for the improvement of the weather service, not only for the coasts, but also for inland stations. It is accordingly of opinion that the proposal should be actively supported on all sides."

The sitting ended at 4h. p.m.

(Signed) H. WILD.

Protocol of the Third Meeting, Thursday, 3rd August.

The Meeting was opened at 10h. a.m.

All the members of the Committee were present.

M. Tietgen was present by invitation of the Committee.

The discussion was opened on Question IV. of the Programme.

M. Tietgen explained the method which he proposed for carrying out the project of the proposed cable, and promised, in accordance with the desire of the members, to submit his remarks in writing for the Report. (Appendix VI.)

The President thanked M. Tietgen for the trouble he had been good enough to take, after which M. Tietgen withdrew.

The Committee decided, at the suggestion of the President, to divide the discussion into two parts, the scientific question and the mode of putting the project into execution.

The discussion of the scientific part of the question was first taken up.

All the members of the Committee were agreed as to the importance of the undertaking for the purpose of weather prediction, and the following resolution was finally adopted :—

"The Committee, with reference to their former utterances on the subject, consider that storm warnings cannot realize all the advantages which may be anticipated from them until regular telegraphic communications are established with the stations situated to the west of Europe, viz., Iceland, America, and the Azores. The prospect of the establishment of this network does not appear to be near, but the Committee is of opinion that a cable uniting Iceland to Europe would meet the requirements which are most urgent; they therefore recommend such an undertaking, and request M. Hoffmeyer to draw up, for distribution by the executive officers of the Committee, a memorandum which will set forth the general interest of the scheme."

This resolution was adopted unanimously.

The Committee then passed to the consideration of the practical side of the question.

On the invitation of the President, M. Hoffmeyer communicated to the Committee several other considerations, in addition to those expressed by M. Tietgen, and which might possibly facilitate the execution of the project by diminishing its cost.

The Committee decided not to frame any resolution upon this point.

The meeting was adjourned at 12h. 30m. p.m. until 2h. p.m.

The discussion was opened on Question III. of the Programme :—

"The plan for International Meteorological Tables for the reduction of observations."

M. Léon Teisserenc de Bort, who was present by invitation, submitted to the Committee some remarks upon the subject of the reduction of the barometer to sea-level. (Appendix VII.)

The Sub-Committee elected at Berne (the President and M. Mascart) submitted to the Committee specimens of tables constructed by M. Mascart.

"SCHEME FOR INTERNATIONAL METEOROLOGICAL TABLES.

List of Tables.

I. Conversion of different thermometer scales.
   1°. Reaumur to Centigrade.
   2°. Fahrenheit to Centigrade.
   3°. Centigrade to Fahrenheit.

II. Reduction of the barometer to 32° F.
   1°. French measures.
   2°. English measures.

III. Mutual conversion of English, French (old and new), and Russian measures for the barometer.
   1°. English measures to millimetres, between 19 and 31 ins.
   2°. Millimetres to English inches, between 540 and 780 mm.
   3°. Russian measures to millimetres, between 535 and 615 half lines.
   4°. Russian measures to English inches.
   5°. Old French measures to millimetres.

IV. Conversion of English measures, both for rainfall and evaporation.
   1°. French lines to millimetres, from 0 to 100 lines.
   2°. English inches to „ „ 0 to 100 ins.
   3°. Millimetres to English inches, „ 0 to 100 ins.

V. Vapour tension.
   1°. French measures.
   2°. English measures.
   3°. Boiling point temperatures, between 680 and 800 mm. English and French measures.
   4°. Tensions per 0°·01 near 100°. C.
   5°. Weight of water in saturated air, per 0·1.

VI. Hygrometer.—Abandoned.

VII. Influence of gravity on barometric readings.
   French measures.
   English measures.

VIII. Reduction of the barometer to sea-level.
   1°. French measures, 2 tables.
   2°. English „ 2 „

IX. Reduction of temperature to sea-level.
   1°. French measures.
   2°. English measures.

X. Conversion of kilometres and English miles per hour to metres per second, and *vice versâ*.

XI. Measurement of heights by the barometer.
  1°. French measures (*a*) Approximate height.
    (*b*) Correction for temperature.
    (*c*) „ „ humidity.
    (*d*) „ „ altitude.
  2°. English measures Ditto.

XII. Conversion.
  1°. English feet to metres.
  2°. French „ „
  3°. Metres to French feet.

XIII. Conversions of English weights (grains) to grammes, and *vice versâ*.

XIV. Conversion.
  1°. Minutes and seconds to decimal parts of an hour, and *vice versâ*.
  2°. Hours and minutes to decimal parts of the day, and *vice versâ*.
  3°. Days to decimal parts of a year, and to arc (1 year = 360°), and *vice versâ*.

XV. Table for calculating the mean direction of the wind by Lambert's Formula.

XV*a*. Table of Natural Tangents.

XVI. Constants for the conversion of magnetic measures.

XVII. Note on electric units."

Mr. Scott undertook to have specimens of the tables, with explanations as to their calculation, printed and distributed to Meteorologists in the name of the Committee, together with a circular asking for their opinions thereon.

The discussion was opened on Question V. of the Programme:—
" The organization of a Tele-Meteorographic System."

M. Capello submitted two Memoirs to the Committee—

I. On the daily temporary telegraphic connection of the Central Offices. (Appendix VIII.).

II. On the desirability of the organisation of a system of simultaneous observations in Europe for the purposes of weather prediction. (Appendix IX.).

M. Buys-Ballot drew the attention of the Committee to the opinions which he had repeatedly expressed as to the importance of the various proposals, which had been submitted to the Committee, to have the readings of the instruments at distant stations recorded at the Central Offices.

The Committee acknowledged the great importance of M. van Baumhauer's and M. van Rysselberghe's ideas, and resolved to request M. van Rysselberghe in particular to publish details as to the carrying out of his plan. The Committee further expressed its opinion that experiments should be made with the various kinds of apparatus proposed.

The sitting ended at 4h. p.m. (Signed) H. Wild.

Protocol of the Fourth Meeting, Friday, 4th August.

The Meeting was opened at 9h. 45m. a.m.

All the members were present.

The protocols of the second and third meetings were read and confirmed.

The discussion was opened on Question VI. of the Programme :—

" The observations of atmospheric electricity."

Upon the invitation of The President, M. Mascart gave the Committee some information as to the methods which may be employed for the observation of atmospheric electricity. He stated that the principles were well established, and that various forms of apparatus proposed up to the present time allowed of comparative results being obtained.

The discussion was opened on Question XVIII. of the Programme :—

" A proposal respecting the observation of the upper movements of the atmosphere."

Professor Hildebrandsson was present, by invitation, and communicated to the Committee particulars as to the method proposed by him for the observation of " cirrus " clouds.

Mr. Scott informed the Committee that since 1880 regular observations of cirrus clouds had existed in the British Isles, which had been organised by the Rev. Clement Ley, and undertook to distribute among the members of the Committee copies of the instructions actually in use in the British system of observations.

The Committee decided to request MM. de Brito-Capello, Hildebrandsson, and Mr. Ley to prepare a Report on the subject of cirrus observations, to be distributed by the executive officers of the Committee.

The discussion was opened on Question II. of the Programme :—

" The preparation and publication of a general catalogue of observations and meteorological memoirs."

The Report of the Sub-Committee—M. Hellmann and Mr. Scott —was read (Appendix X.). A letter from Mr. Symons, dated 5th July, was also read. (Appendix Xa.).

Mr. Scott reported that he had already received catalogues of memoirs from the Netherlands and Saxony, and of the publications of the Observatory of the Infanta Dom Luiz.

M. Mascart submitted to the Committee a specimen of the Library Catalogue of the Meteorological Society of France, of which he had made mention at Berne.

The Committee recommended Directors of Central Offices to prepare special catalogues for their own countries, pending the publication of a general catalogue.

Mr. Symons's proposal to have the titles of the publications of the different offices printed and sent out with the books was adopted.

As to the catalogue of Observations, the Executive Officers were invited to issue a circular to Meteorologists calling attention to the resolutions of the Congress of Rome, and of the meeting at Berne, with reference to these catalogues.

The meeting was adjourned at 12h. 20m. p.m. until 2h. 10m. p.m.

The Sub-Committee elected at the first meeting brought forward the Circular which they had prepared for the collection of information as to the different organisations, Point VII. of the Programme (Appendix XI.).

This Circular was adopted.

The discussion of Question XIII. of the Programme was then taken up.

It was agreed to publish the Report of the Committee in three languages, like that of the Berne meeting.

The German edition by M. Neumayer.
„ English „ Mr. Scott.
„ French „ M. Mascart.

These gentlemen respectively expressed their readiness to undertake this duty.

The President thanked the members of the Committee for the attention which they had given to the discussions, and expressed the hope that the second meeting of the International Meteorological Committee would ensure a true advance in Meteorological Science.

The meeting was closed at 3h. 30m. p.m.

(Signed) H. Wild.

APPENDIX.

APPENDIX I.

Programme.

1. Report of the Secretary on the action of the Committee since the meeting at Berne.

2. The preparation and publication of a general catalogue of observations and meteorological memoirs.

3. The plan for international meteorological tables for the reduction of observations, &c.

4. The definition of the interest to meteorological science in the establishment of telegraphic cables connecting the Azores and Iceland to Europe.

5. The organisation of an international tele-meteographic system :—

5*a*. M. Capello's proposal : The temporary telegraphic connexion of the central offices.

5*b*. „ „ On the utility of simultaneous observations in Europe.

6. The observations of atmospheric electricity.

7. International collection of the systems of storm warnings, &c. to the coasts of different countries, for the International Fisheries Exhibition in London, 1883.

8. M. Köppen's proposal (made at the Berne meeting) as to the symbols for hydrometeors, &c.

9. M. Hoffmeyer's proposal (made at the Berne meeting) respecting the publication of mean values of telegraphic observations.

10. Report on the degree of conformity with the decisions of the Congresses of Vienna and of Rome, of the instruments and methods of observations actually in use (Congress of Vienna).

11. Proposal to invite M. Hoffmeyer to be present at the meetings of the Committee.

12. M. Cantoni's proposal to resign his seat on the Committee in favour of M. Tacchini.

13. The preparation and publication in three languages of the Reports of the meeting, by the executive officers.

14. Is it desirable that the number of members of the Committee should be increased, by the addition of certain persons representing other important meteorological organisations ?

15. M. Hann's proposal : The members of the Committee are requested, if possible, to bring under the notice of meteorologists the results of observations of stations, at least during the period of the International Polar Stations, which do not belong to any meteorological system, and which appear either irregularly, or in local publications, and are always difficult to procure. This is particularly desirable for stations situated in the intervals between the existing systems, especially in tropical regions.

16. A communication from MM. Hoffmeyer and Neumayer on the subject of the proposed issue of daily synoptic charts and weather reports from the area of the North Atlantic Ocean and the countries bordering on it, as already discussed at the Congress of Rome and the meeting at Berne.

17. M. Buys Ballot proposes to direct the attention of meteorologists to the importance of the study of evaporation not only from a free water surface, but also from surfaces of different characters, as, for instance, of sand, of clay, &c.

18. Proposal respecting the observations of the upper movements of the atmosphere :—

1°. A committee should be nominated to draw up simple instructions for the observations of clouds. These observations should be made at a certain number of suitable stations. The instructions should be limited to the following observations:
   (1.) The movement of the lower clouds.
   (2.) The movement of upper clouds, or cirrus.
   (3.) The direction of the radiant points of cirrus clouds.

2°. Full observations of cirrus are earnestly recommended by the International Meteorological Committee. For the present, however, these observations should be taken only by observers specially interested in these difficult studies. Before commencing the observations it is necessary that the nomenclature should be perfectly definite, and the phenomena to be observed strictly determined.

APPENDIX II.

Report of the Secretary upon the Work of the Committee since the Meeting at Berne.

The Report of the Berne Meeting has been published in three languages, the English edition in 1881; the German and French editions at a later period.

As to the resolutions of that meeting:—

(i.) The International Polar Committee held a meeting at St. Petersburg in August 1881. The expeditions, in number, 13 for the Northern, and 2 for the Southern Hemisphere, sent out by the different countries taking part in the undertaking, have already started for their respective destinations. It is to be hoped that most of the expeditions have by this time commenced taking their observations, and that the others will begin during the current month.

Thus the undertaking, notwithstanding the lamented death of its originator, presents a very favourable prospect of being fully realised.

The officers of the Committee have forwarded the Bulletin which they have published, as a report of their operations.

(II.) M. Hoffmeyer's proposal as to the publication of monthly means for international and telegraphic stations has not received the attention which it deserves. Possibly the present meeting could, by a special circular, invite meteorologists to consider this important question.

III. M. Köppen's proposal, as to the publication of information about hydrometeors, has hardly been brought under the notice of meteorologists, except by publication in the *Zeitschrift* of the Austrian Meteorological Society.

Is it desirable to take any steps at present in the direction indicated by the resolution of the Berne meeting?

I have the honour to submit to the Committee, the following list of documents which have been received since August 1880.

A. M. Houzeau's report on the conformity of methods, &c. in Belgium to the decisions of the Congress of Vienna.

B. Report of the sub-committee (M. Hellmann and Mr. Scott), on the preparation of a general meteorological catalogue.

B*a*. A letter from Mr. Symons on the same subject.

B*b*. Lists of published meteorological memoirs from—

1. The Netherlands.
2. Portugal.
3. Saxony.

C. The report of the Second Intercolonial Conference of Australasia, held at Melbourne 21–27 April 1881.

D. A proposal by M. de-Brito Capello for the introduction of simultaneity in the observations for the telegraphic service in Europe.

E. A proposal by M. de-Brito Capello for the temporary telegraphic connexion of the Meteorological Institutes.

F. The Committee of the International Fishery Exhibition requests the International Meteorological Committee to organise for that Exhibition a complete series of the different systems which exist for the communication to Fishermen of information about the weather.

G. A letter from M. Buys Ballot, dated 11th February 1882, on the "Telemeteorographs" of M. Olland and M. van Rysselberghe.

H. M. Neumayer has informed the Committee that the Great Northern Telegraph Company has undertaken to send the telegrams for the Polar Expedition *gratis* as far as Stromness; and Mr. Scott has stated that the London and North-Western Railway Company and the Grand Trunk Railway Company have also kindly consented to forward the baggage of the British Expedition *gratis*.

(Signed) Robert H. Scott.

APPENDIX III.

Sir, Rome, July 3, 1882.

I have been obliged to delay considerably this reply to your very obliging invitation to the next meeting of the International Committee at Copenhagen owing to the long and serious illness of my wife. I am in hopes of a speedy improvement, but I am sure that it will not now be possible for me to go to Copenhagen.

I should regret exceedingly that Italy should not be represented at this important meeting of the International Committee. For this reason I venture to request, sir, that you will consent to the substitution of Prof. P. Tacchini, the Director of the Central Meteorological Office of our kingdom, in my stead.

He is better acquainted than I am with the conditions and requirements of our meteorological service, and he is by his position at the head of the science in our country.

I therefore request you to admit him instead of me at this meeting, and also that he may be permitted to replace me in future on the International Committee.

I shall be obliged by a word in reply.

Accept, &c.

Dr. H. Wild, (Signed) G. Cantoni.
President of the International Meteorological Committee,
St. Petersburg.

Sir, Varese, July 27, 1882.

I regret that the delay in my communicating to M. Tacchini your letter of the 13th instant, owing to my absence from Rome, will prevent him from reaching Copenhagen by the 1st August next, especially as he has to settle several urgent matters, and among others, business connected with the new observatory upon Mount Etna.

I beg, however, sir, that you will induce the other members of the International Committee to accept my proposal to resign my seat upon that committee in favour of M. Tacchini.

I thank you for your courteous letter and beg you to accept, &c.

(Signed) G. Cantoni.

Prof. H. Wild,
President of the International Meteorological Committee,
Copenhagen.

APPENDIX IV.

The Great International Fisheries Exhibition, London, 1883.

Sir, London, July 8, 1882.

I have the honour to forward to you herewith a copy of a Resolution passed at a meeting of the Executive Committee of the Great International Fisheries Exhibition, London, 1883, and to ask your kind assistance in carrying through the object desired.

I have, &c.

(Signed) B. F. Brandreth Gibbs,
Director and Secretary.

To R. H. Scott, Esq., M.A., F.R.S.,
Meteorological Office,
116, Victoria Street, S.W.

"That Robert H. Scott, Esq., M.A., F.R.S., Secretary to the Meteorological Council, be asked to bring the Great International Fisheries Exhibition, London, 1883, to the notice of the International Meteorological Committee at their meeting in August next, at Copenhagen, with the view of urging the members to arrange for a combined international representation at the said Exhibition of Storm Warnings, and of the mode of giving weather intelligence to fishermen."

APPENDIX V.

Report of the Second Intercolonial Conference, held at Melbourne April 21–27, 1881. (Abstract.)

The Conference was attended by the same gentlemen as on the previous occasion of its meeting, viz.: Messrs. Ellery (Victoria), Hector (New Zealand), Russell (New South Wales), and Todd (South Australia).

It was reported that neither Queensland, Tasmania, nor West Australia, had appointed representatives to take part in the Conference.

Mr. R. J. Ellery, F.R.S., was elected President.

The proceedings opened with the reading of reports by the different members on the action taken in their respective colonies to carry out the resolutions of the Sydney Conference of 1879.

Special reports were then read on the subjects referred to the members at that meeting, viz.:—

1. Shade temperature.
2. The sling thermometer.
3. Hygrometry.
4. Anemometry.
5. Solar radiation.
6. Evaporation.

(1) and (2.) Comparisons between the sling thermometer and various thermometer screens had been made by Messrs. Todd, Russell, and Ellery. Mr. Todd preferred an open wooden screen, Mr. Russell had employed the Greenwich screen, and Mr. Ellery had used a special screen, a shed of galvanized iron with a double roof, and stated that the results he obtained therewith agreed very well with those of the sling thermometer.

(3.) *Hygrometry.*—Mr. Russell alone reported on the employment of maximum and minimum thermometers for the psychrometer.

(4.) *Anemometry.*—Mr. Ellery communicated the results of comparisons between Hagemann's and Robinson's anemometers, and expressed his general approval of the former. Mr. Russell submitted a specimen of a hand anemometer he had devised for use at his telegraphic reporting stations.

(5.) *Solar radiation.*—No definite recommendations were made.

(6.) *Evaporation.*—Mr. Russell exhibited a sketch of the atmometer in use at Sydney, with a table of the results obtained therewith.

Resolutions were adopted tending to consolidate the system of intercolonial weather service. The coast lines of the south and east of Australia were divided into several districts, and the interior into two, for the purpose of telegraphy to New Zealand. A word code, like that in use in the United States, was preferred to the figure code in use in Europe.

The Conference finally referred most of the questions, on which reports had been presented, for further and fuller consideration.

The Appendix to the Report contains the names and geographical co-ordinates, with the altitudes, of the stations at which complete and regular observations are made. These are distributed as follows:—

New South Wales -	29
New Zealand - -	15
South Australia -	13
Victoria - -	14

APPENDIX VI.

Proposal for a Telegraphic Cable to the Faroë Isles and Iceland.

Sir, Copenhagen, August 4, 1882.

You have done me the honour of asking, in the name of the International Meteorological Committee, for a statement in writing of the remarks which you were good enough to allow me to make orally to the Committee upon the question of the establishment of telegraphic communication between Iceland and Europe; an undertaking which has occupied my attention for some years past.

The following is that statement:—I propose that the cable should start from Thurso and should be carried to the Faroë Isles and to Berufjord, and Reikianæs in Iceland, and that stations should be established at these three places;

That the communication between the two last places should be established by submarine cable and not by an ordinary wire, owing to the difficulty of repairing interruptions in a country which is almost without roads and is very thinly populated;

That the cables should be very strong in order to protect them against tides and currents.

The carrying out the project, on these conditions, would cost about 200,000*l.*, and as the commercial and private messages would not cover at most more than the cost of working the cable, the sum necessary for interest, repayment of principal, and repairs, should be contributed by the Governments interested in obtaining the important addition to the existing daily meteorological observations, which it would be the object of the undertaking to provide.

I estimate that for these expenses an annual sum of 10 per cent., or 20,000*l.*, would be required, and I propose that this amount should be provided by the different countries, in proportion to their extent, population, and the importance of their navigation, &c., in the form of a subscription for 20 years and for three meteorological telegrams daily, but charged at a rate varying according to the proportion above mentioned, the countries being classed in three lists, for example :—

1st List.	2nd List.	3rd List.
Denmark.	Russia.	Holland.
England.	Germany.	Sweden.
France.	Norway.	Portugal.
		Austria.

and fixing the tariff of the 1st list at 3*l.*,

" " 2nd " 2*l.*,

" " 3rd " 1*l.*,

per telegram, which would amount to,—

3 × 3 × 365 × 3*l.*	- -	= £9,855
3 × 3 × 365 × 2*l.*	- -	= 6,570
4 × 3 × 365 × 1*l.*	- -	= 4,380
Total	- - -	£20,805

or for each country in the 1st list 3,285*l.* per annum.

" " 2nd " 2,190*l.* "

" " 3rd " 1,095*l.* "

I think that the scheme would be more easily realised, upon the basis I have just indicated, than upon that of a fixed annual subvention, because the countries or meteorological offices have only to contribute according to the number of telegrams that they receive, and the negotiations can be taken up with each Government separately, instead of the realisation of the undertaking being made dependent on the adoption of a general agreement as to all the essential points among the different countries interested.

I venture to hope that the Meteorological Committee, which is already convinced of the great scientific importance of this undertaking, as has been expressed at several previous Conferences, will recommend to their respective Governments the carrying out of the scheme, with such modifications as they may find desirable.

Accept, &c.

(Signed) C. J. Tietgen.

APPENDIX VII.

On the Reduction of the Barometer to Sea-level.—Importance of the Exact Determination of the Co-efficient of Decrease of Temperature with Height.

The reduction of the barometer to sea-level is an operation, the object of which is to furnish us with a term for comparing pressures observed at different heights.

If the temperature and its mode of decrease in the air were constant, the operation would be much simplified, because, on rising by any given amount, we should again find readings which differed very little between themselves, and these differences could easily be calculated, allowing for the initial pressure.

Thus the differences which might exist between the reduced readings would no longer be attributable to the reduction, but would depend upon dynamical effects and the arrangement of the isobars.

But in the atmosphere, the temperature varies with the geographical position, and its mode of decrease changes from one point to another. It results that for equal heights, while starting with the same pressure, the variation of the pressures is very different, owing to the different temperatures in the strata of the atmosphere.

This inequality of the temperatures, which influences the density of the strata of air at the different points under consideration, greatly complicates the solution of the problem. In order to study more easily what takes place in the atmosphere, it is necessary to employ a graphical reproduction of the arrangement of the curves of equal pressure. Suppose that the curves of equal pressure assume in the atmosphere the lines indicated by the following figure:—

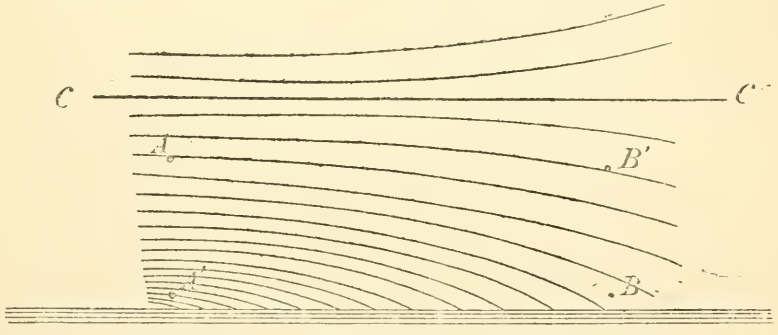

Fig. 1.

Suppose we have observed, at the point A., in a balloon, a pressure P. which we wish to compare with the pressure at the point B, situated at the sea-level. If, by former experiments, we know the value of the decrease of temperature from A to the sea-level, we could determine by means of this co-efficient and of the temperature observed at A, the mean temperature of the stratum of air A A′, and consequently we could calculate exactly the pressure at A′ and its difference from B.

The gradient between A′ and B will be thus determined by means of the pressure at A. In this case, the reduction of the pressure to sea-level is an operation which corresponds to a real fact, and may in a certain measure take the place of the direct observation at A′.

But its accuracy depends mainly upon the accuracy with which we know the mode of decrease of temperature between A and A′, not taking into account dynamical disturbances.

§ I. Barometrical observations made on continents.—Suppose now that with the same arrangement of the curves of level, the elevation of the ground be such (Fig. 2) that the point A, instead of being in the atmosphere, be situated on a continent, so that the portion A A′ B, instead of being occupied by air is filled up by the ground.

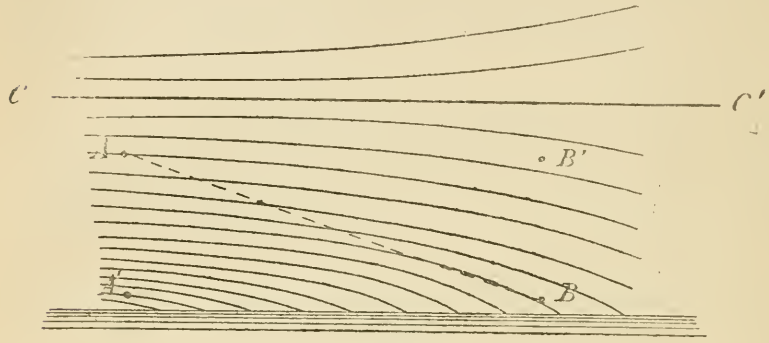

Fig. 2.

In this case, we assume, for reducing the pressure to the level of the sea, that the atmosphere is continued below A as before, and the calculation of the reduction is done in the same way; but it is seen immediately that it is a numerical operation which does not correspond to a real fact: as M. Hann has so well said, it is a fictitious reduction. We must therefore ask what is the value of the gradient thus obtained.

As we may observe, by continuing the atmosphere in a theoretical way, we augment the differences of pressure; it may be seen, in fact, that the curves in the real part of the atmosphere are more open, since they approach each other towards A A′. Now their distance apart depends upon the gradient, on the variation of temperature towards the interior of the continent, and on the slower decrease of temperature. These three causes, which increase from B B′ to A A′, act upon portions of the atmosphere becoming less and less considerable in proportion as we approach A, while in our reduction they are supposed to act on this entire column of air with the intensity that they have at A A′. The calculated weight of the column is therefore superior to the weight of a column of the same length and composed of air at the actual density of the atmosphere.

In fact, what puts the air in motion in the lower strata are the differences between the horizontal pressure, existing near the ground, in the successive layers of air extending from A to B. Let us imagine in fact, this space from A to B divided into a series of vertical sections. A small mass of air, M, placed in one of these sections, tends to pass into the adjacent couche by the difference of pressures existing between them at the same height; now we can express this difference of pressure by an equation.

In fact by ascending as far as the curve of same pressure C C′, let P be the pressure at CC′ and l the distance from CC′ to the point where the little mass m is situated.

The pressure of the column m, or P′, will be expressed by :—

$$\text{Log } P' = \text{Log } P - \frac{l}{A + nl + Kt.}$$

The pressure PP′ at the same height in the adjacent column is expressed by :—

$$\text{Log } P'' = \text{Log } P = \frac{l}{A + nl + Kt'.}$$

The difference between the two gives the infinitely small gradient which tends to push m towards B′ B.

In its movement towards B, when the little mass m gets a little lower, the infinitely small gradient will be given by the difference between two analogous expressions, where l will become l', and the temperatures t'' and t'''.

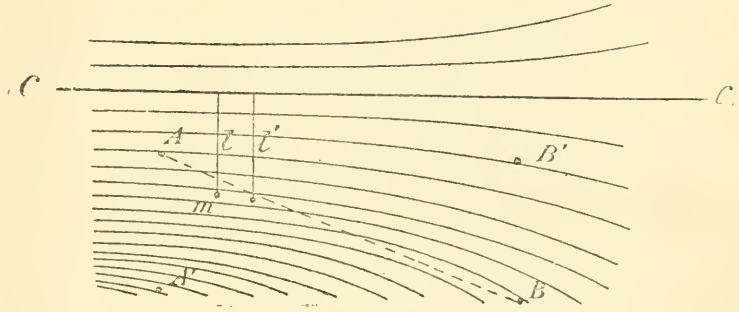

Fig. 3.

It is the sum of these differences which, in the movement of the air from A towards B, represents the horizontal force which tends to carry the air towards B. Now it is well to remark that the sum of these successive differences is equal to the total difference between the two stations which represents the numerator of the gradient when the air rests upon a horizontal surface.

In the other cases it is made up by the difference of the pressures at A′ and at B and the difference of the pressures at A and at B′.

If we wished, by a method of this kind, to calculate the gradients, it would be necessary to know as exactly as possible, the co-efficients of the decrease of temperature.

§ II. In order to avoid what is fictitious in the usual reduction, we might calculate the difference of pressure in another way, and find what the pressure is above B at the same height as A, that is at B′; the comparison of the observed and calculated values would give the gradient. M. Hann in his "*Zeitschrift für Meteorologie*," for 1879, p. 82, has shown the advantages of this method. Although this method has the great advantage of corresponding to a real fact, for the difference of pressure between A and B′ really exists, yet it cannot be substituted, in a general way, for the theoretical method in use for studying the circulation of the atmosphere at the earth's surface. If this increases the gradients, the other diminishes them to a considerable extent, and may even completely suppress them.

In the example that we have chosen, let us suppose the point A to be near to CC′, the differences between the pressures near this curve will be very small at the same height, the gradient calculated will be very slight, and might even be nothing if the point A were nearer to CC′,

while between A and B the inflexion of the curves of level indicates to us a very appreciable difference of pressure, and there is no doubt that between these two points there would be a current of air in the direction from A to B.

Now the arrangement of the lines of level which we have taken as an example explains the circulation of the air between the continents and the oceans during winter, and it is therefore not an arbitrary example.

Finally, whether we wish to employ the usual method, whether we wish to adopt the principles indicated in paragraph 1, or, whether we employ the method explained by M. Hann, it is indispensable that we should know pretty exactly the co-efficient of the vertical decrease of the temperature of the air.

It seems to me that experiments should be made upon this point; M. Wild, for instance, admits in Russia a decrease of 1° for 260 metres in winter, in France we usually adopt 1° for 200 metres as a co-efficient for the cold months. Is that due to a different method of discussing temperature observations, or to the fact that the decrease of temperature is usually different in Russia?

If we have to draw isobars over large areas we do not know what coefficient to adopt for intertropical countries; it is very likely that the co-efficient for the summer months is that which suits them generally, but the high table-lands, like Mexico, have a rather marked winter, so that perhaps the co-efficient of decrease in such cases should be that of winter.

Certain localities, like St. Helena, afford data showing that the decrease may be as much as 1° per 100 metres* for several entire months.

The variation in the co-efficient of decrease varies also from one day to another, and the evidence of recent winters has drawn attention to the frequency of inversions of temperature.

It appears to me therefore, that with the precision which meteorological science gains from day to day, the study of the decrease of temperature with height, in different countries and under different atmospherical conditions, is of great importance for the extension and accuracy of all our isobaric charts, for the calculation of gradients, &c.

Accordingly I venture to call the attention of the International Meteorological Committee to the following propositions:

1°. The co-efficients to be employed for the calculation of the mean temperature of the stratum of air in the reduction to sea-level are not known sufficiently accurately for different regions, and for the various conditions of the atmosphere, to enable us to indicate them in the international tables.

2°. Investigations made in this direction on table-lands, mountains, and in balloon ascents, are especially recommended.

3°. The manner in which the temperature has been calculated for the reduction of the barometer should be indicated in Meteorological memoirs.

4°. The Committee should recommend the publication in daily or monthly bulletins of the observations of mountain stations, with the addition of the pressures reduced to sea-level.

These observations, in fact, possess great interest, because they teach us something of what is going on in the upper regions of the atmosphere. The reduction of the pressures to sea-level, especially if the temperature at the base of the mountain is observed, may give curious results, so far as regards the study of dynamic phenomena.

(Signed) LÉON TEISSERENC DE BORT.

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* See "*Zeitschrift für Meteorologie*," 1879, page 403.

APPENDIX VIII.

On the Temporary Daily Telegraphic Connexion of the Central Offices.

M. Buys Ballot's proposal is without doubt the ideal and true system of meteorological connexion, as everyone would acknowledge. But I am afraid that the initial outlay would for some years prevent the adoption of such a beautiful and complete system. Pending the introduction of such a system, I have the honour to submit for the consideration of the International Committee a more modest proposal, which, although not presenting such advantages, or aiming so high as the former, might, however, render good service.

All neighbouring countries are connected by several international lines of telegraph. Between Portugal and Spain there are five such lines. I think it would be quite possible to obtain direct connexion between neighbouring central offices, for a certain time each day, during the slack hours of telegraphic business.

The directors of central meteorological offices, with the consent of the directors of telegraphs, or of their respective Governments, might easily arrange for one of the international lines to be placed at their disposal say for 30 or 40 minutes ; during this time they might communicate directly the state of the weather and the latest evening reports from stations previously agreed upon, together with any matters of interest. To effect such a connexion it would only be necessary to erect a sufficiently powerful battery at each central observatory; and if in a more or less distant future, telegraphic communication becomes more easy and certain, this is doubtless the method which should be employed. It appears to me that the realisation of this plan will not present great practical difficulties, in so far as regards continental offices. It would be of great advantage for the prediction of weather and especially for warnings of bad weather or storms, when depressions advance suddenly.

(Signed) J. Capello.

Observatory of the Infanta D. Luiz,
18th July 1882.

APPENDIX IX.

On the Desirability of the Organisation of a System of Simultaneous Observations in Europe for the Purposes of Weather Prediction.

Would it be desirable to organise such a system of simultaneous observations in Europe ?

The utility of simultaneous meteorological observations for the study of the formation and propagation of atmospherical disturbances is not disputed by meteorologists. The United States of America were the first to make use of this system of observations on a large scale, and the great progress of weather prediction in America is without doubt due to this method of observation.

There is no need, therefore, to demonstrate that it is only by means of simultaneous observations that we can learn the real form of the isobars, and represent by this means the atmospheric depressions, their centres and motions.

Every one admits that the isobars are subject to rapid transformations, especially when they assume an elliptical shape. In the centres of these

curves the alternate fall and rise of the barometer, and above all, the variations of the wind, are very rapid, and this may lead us into serious errors, if the observations are made at different epochs.

For the last five or six years simultaneous observations, once a day, synchronous with the 7h. a.m. observation of the United States, have been made at the principal observatories of Europe and at several stations; but these observations, which are published at the expense of the Signal Office, although of great value in the study of meteorology, do not serve, nor can they serve, for the prediction of weather in Europe. The observations for this service are made with us at local time, and this local time is different in different countries.

Correspondence with the United States' system of simultaneous observations, whatever be the hour chosen from the three daily epochs (7, 3, and 11, Washington time), appears to me unsuitable for the European service of weather prediction.

Hence it is necessary to establish an independent system.

The difficulties are well known, and they may be reduced to two principal classes:—

1°. The necessity of changing one of the hours of observation at all observatories and stations. Such a change is always unpopular, and at certain stations is carried out with difficulty.

2°. The choice of a suitable hour for the observation, so that it may not be inconvenient for the western stations, on account of being too early, nor for the eastern stations, on account of being too late in the day, which would make it difficult to transmit the meteorological reports by telegraph.

The western countries are doubly ill-used by meteorology. Their observations must be taken at more inconvenient times, and, on the other hand, they cannot be forewarned of the storms or depressions coming from the ocean. These countries are able to warn eastern countries, and the latter, while they receive the warnings from the former in useful time, are not obliged to take simultaneous observations so early.

This subject is important for the progress of Meteorology, and it would be proper to see if the difficulties are insurmountable, or if it would be possible to reduce them to a minimum.

In the first place, we should inquire whether it would be possible to reduce the number of stations for the study of weather prediction. M. Buys Ballot mentions 50 leagues (250 kilometres) for the mean distance between the stations. There is no doubt that the position of the observatories or stations is more important than their number, or even than the distance between them.

If it is possible to diminish the number of stations, especially those to the east, the work of telegraphy would be reduced.

With respect to the time of the First Meridian that should be adopted, it appears to me that it would be convenient to choose an hour near that actually in use at the western stations, say 8h. a.m., Paris time, during the whole year. In this case the change of hour would not be very great for the most westerly stations. The Portuguese and Irish stations would take their observations after 7h. a.m., Valencia, at 7h. 9m. a.m., Lisbon, 7h. 14m., Corunna, 7h. 18m., and Funchal, being at present the most western station, at 6h. 43m. a.m. The English and Scotch stations between 7h. 20m. and 8h. a.m.; the Norwegian and Swedish stations between 8h. and 9h. a.m., as well as a large part of France, Germany, and Italy; Austria, and a part of Russia between 9h. and 10h. a.m.; the latest would be Moscow and Archangel, at about 10h. 20m. a.m.

These last hours would be inconvenient for telegraphic transmission, but on the other hand, the observations from the western countries, which are the most necessary for the prediction of weather, would be transmitted more rapidly if they were generally taken earlier than they are when local time is employed.

If meteorological telegrams were considered by all telegraphic directors as service telegrams, that is if they always had precedence, the objection of inconvenient hours would no longer exist. I think this subject is one of the points to which the directors of central offices should give their attention.

The objections as to the inconvenience of hour in the western countries are, perhaps, more serious, and more difficult to be overcome. For instance, the time of observation at Funchal (6h. 43m. a.m.) during winter is too early. The difficulty would be greater at the Azores, if these islands were connected telegraphically; but in this case an observatory would be established in the group with a more skilled and numerous staff than the present observers.

Let us now see whether it would be advisable to connect the European simultaneous observations with the three hours of the United States system, for the study of probable weather. In this case it would be necessary to completely modify our system of weather prediction; this would have to depend upon the night observations instead of day ones.

The most convenient Washington time would be 3h. p.m., which corresponds to 8h. 18m. Paris time. For other countries the hours would consequently be advanced by 18 minutes, but this would take place in the evening instead of the morning. In the most eastern countries the hours would fall later at night, up to 10h. 37m. at Archangel.

As far as telegraphic transmission is concerned, the proposed system would, perhaps, be more convenient, for the wires would be freer in the afternoon than during the morning hours. The weather forecasts drawn during the night could be sent to the morning newspapers, which could publish them together with the weather report.

The 11h. p.m. observation (Washington time) would be very inconvenient in consequence of its being too early; it would correspond to 3h. 31m. a.m. for Lisbon, and to 4h. 18m. a.m. for Paris.

From all these combinations we may conclude that the existing hours of the American system do not appear to suit for Europe.

All of these considerations are not new, the subject has been already discussed; but it appears to me that it is now time to reconsider this question of simultaneous observations for the daily service of weather predictions.

I admit that this question cannot be solved by the International Meteorological Committee, but I submit it for the consideration of the directors of central offices and observatories, in order that it may be studied in all its bearings, and that it may be decided whether the advantages of a simultaneous system do not exceed its disadvantages.

(Signed) J. Capello.

Observatory of the Infanta D. Luiz,
18th July 1882.

APPENDIX X.

Report on the proposed Meteorological Bibliography.

London and Berlin, June 1882.

The under-mentioned Sub-Committee elected by the International Meteorological Committee at their fifth meeting at Berne on the 11th August 1880, for the further consideration of the question of the preparation of a general Meteorological Bibliography, had, in accordance with the proceedings of the above-mentioned meeting, the special task of taking the necessary measures for the preparation of the proposed work on a uniform plan, in accordance with the requirements of the programme, in case the Meteorological Office of London might possibly be able to undertake the printing *gratis*.

As, however, the Meteorological Council, at its meeting of the 12th January 1881, decided that it could not defray, from the vote of its Office, the cost of the technical preparation of the Meteorological Bibliography and as, also, it was clear from previous reports and deliberations upon this subject, that at the present time the realisation of the plan was not practicable, either by means of subscriptions or as an ordinary publishing venture, the Committee were henceforward obliged to take up an expectant attitude, and could only undertake to induce the Directors of the various Meteorological systems to publish special bibliographies for their respective countries.

Under existing circumstances this appeared to be the surest way to attain the desired end, as the preparation of a general bibliography of Meteorology could naturally be effected with comparative ease by a single expert at the cost of the publishers, if such individual bibliographies existed for the most important countries or languages.

We were confirmed in this opinion by our experience gained during the preparation of such a special work for Germany. It was then shown that this could only be done in the country itself, with access to a great library, and with the co-operation of almost all the large libraries of the country, or else the results would be very defective and imperfect.

The Sub-Committee is in the fortunate position of being able to report some progress and some results in the direction of local bibliographies.

Under the direction of M. H. H. Hildebrandsson, an alphabetically arranged index, containing the Swedish Meteorological publications for the last 35 years, from 1856 to 1881, has been published by M. C. G. Fineman, in the "Nordisk Tidschrift" for 1881, and has also been separately printed. It contains the names of 61 authors, and about 170 titles of works.

The Brussels Observatory, whose library has been considerably increased during the last few years, is preparing a second edition of its catalogue published in 1878, which will be of great use for the above-mentioned purposes.

In the same way the catalogue of the "Deutsche Seewarte" at Hamburg, which will probably be sent to press in the beginning of the year 1883, will prove very useful.

Mr. Sohncke has published in the Seventh and Twelfth Annual Reports of the Central Station at Carlsruhe, two lists of meteorological works and treatises, relating to Baden.

By the completion of Riccardi's *Biblioteca Matematica Italiana*, Modena, 1870–1880, a good foundation has been laid for Italy.

The only comprehensive special meteorological bibliography (including terrestrial magnetism) of whose partial completion the sub-committee has cognizance, is that being prepared by Dr. Hellmann for Germany, which will also comprise a catalogue of observations, &c., &c.

The work, of which a printed-off sheet is appended for inspection*, will probably appear next October under the title "Repertorium of "German Meteorology. Contributions by Germans of pamphlets, "Inventions, and Observations, in the Domain of Meteorology and "Terrestrial Magnetism, from the earliest times until the year 1881." The first part (Bio-Bibliography) contains about 12,000 titles, distributed between about 2,000 authors. These figures, in comparison with those formerly estimated as the probable number for the aggregate work of the general bibliography (32,000 titles), clearly show the necessity of distributing the work in the way above mentioned, if the whole should possess such a completeness and finish as it is desirable, and is also possible to attain. Independently of the efforts of the International Meteorological Committee towards the production of a General Meteorological Bibliography, although only indirectly promoted by them, it appears from statements by Mr. Symons (Monthly Meteorological Magazine, February 1882) to be the intention of the Chief Signal Officer of the United States, General Hazen, by combining the extracts made by Prof. Cleveland Abbe from the Royal Society Catalogue and the M.S. Catalogue of Meteorological Works collected by Mr. Symons, and also by making use of other available materials, to publish a preliminary General Bibliography of Meteorology.

Whether, and how far the support promised in this work by individual members of the committee meeting at Berne with respect to the bibliography proposed by the Congress will be asked for, is unknown to the sub-committee. The sub-committee think, however, that they should in the first place hold to the views above expressed, and strive to obtain special bibliographies for the different countries, but are of opinion that the intended work by General Hazen is "acceptable as "a working index, and a first contribution towards the exhaustive "work that is desired," and that the carrying out of the plan, if possible, should receive every support.

(Signed) Robert H. Scott.
G. Hellmann.

To M. H. Wild,
President of the International Meteorological
Committee, St. Petersburg.

P.S.—It should also be mentioned that the Meteorological Society (London) has already published as a supplement to the Seventh Volume of its "Quarterly Journal" an "Index to the Publications of the English Meteorological Societies, 1831 to 1881." We have the honour to annex a specimen of the Appendix XX. to the "Annual Report of "the Meteorological Council," which appears yearly,† and which contains a catalogue of the additions to its library during the year.

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* Specimen of Dr. Hellmann's Catalogue:—

Abendroth, William. Dr. phil. Prof. d. Math. u. Phys. a-Gymn. zum heiligen Kreuz in Dresden (or), geb. 1838, Juli . . . Pirna.
Ueb. die opt. Erscheinungen in d. Atmosphäre. Jahresb. ver. Erdk. Dresden XV., 1878, p. 40.

† Specimen of Meteorological Office Catalogue:—

A—AGRICULTURE AND BOTANY.

Ritter, C.—Influence des forêts sur les nappes liquides souterraines et sur pluie. 22 pp. 8°. Paris, 1880.

APPENDIX XA.

62, Camden Square, London, N.W.,
July 5, 1882.

DEAR MR. SCOTT,

I SHOULD be greatly obliged by your calling the attention of the Permanent Committee to the fact that many of the Meteorological Institutes have not yet followed the example of the English Meteorological Council and of the Bureau Météorologique de France, by giving upon the cover, or at the end, of each of their publications a list of all their previous works. Such lists would be useful to everybody (1) as check lists by which the completeness of the series received by each can be verified and (2) because then each individual publication will serve to acquaint scientific men with much of what has been published by each Office.

In the catalogue which I am preparing for the United States Government the absence of these lists will undoubtedly reveal itself prejudicially, though I am doing my utmost to avoid omissions.

I regret also to notice that in many countries the acknowledgment of "books received" is printed in a very incomplete manner. The titles need not perhaps be printed *in extenso* (though personally I should prefer that being done), but the author's name, the place of publication, and the date should always be stated.

The following proposal would, I think, save much time and trouble and ensure greatly increased accuracy.

Along with each published work let there be enclosed three copies of its title, so printed as not to occupy more space than 4 in. by 2 in. (10 c.m. by 5 c.m.). These slips should be used as follows :—

(1.) Should be gummed on a card and would be ready for addition to the catalogue of each institute receiving the work.

(2.) Should be put ready for forming the list of "books received."

(3.) Would be available for the formation of a *subject* catalogue should the receiving institute have established one.

I will send in a few days specimens of what I have above proposed.

Yours, &c.

R. H. Scott, Esq., M.A., F.R.S. (Signed) G. J. SYMONS.

Robertson, Dr. H.—A General View of the Natural History of the Atmosphere, and of its connection with the Sciences of Medicine and Agriculture; including an Essay on the Causes of Epidemical Diseases. 2 Vols.

8vo. *Edinburgh*, 1808.

APPENDIX XI.

Circular. St. Petersburg and London,
31st December 1882.

Sir,

The information respecting the meteorological organisations of the different countries which have hitherto appeared in the reports of the Permanent Committee, or of various individual central offices, are too scattered, and are not sufficiently uniform in their arrangement to allow of easy and satisfactory reference.

The Committee are of opinion, therefore, that a general summary of the present condition of the organisations should be prepared, and printed in their Report.

In order to ensure the accuracy of the summary, it is necessary to request the central offices to furnish the necessary information. These communications will be printed in the General Report as nearly as possible in their original form.

It appears to the Committee that it is desirable to append to their request for this information a form for the entries, and they recommend the under-mentioned form for adoption :—

I. General definition of the meteorological system.
II. Number of stations of the First, Second, and Third Order, and especially of the stations of First Order, with their geographical position.
III. The organisation of the stations of the First, Second, and Third Order, the hours of observations, indication of the instructions to the observers, of the tables for reduction employed, and the check to which the observations are subjected.
IV. The special observations, *e.g.*, thunderstorms, hail, periodical phenomena, the return of the seasons, and a statement of the number of stations.
V. Observations at sea.
VI. The organisation of the telegraphic weather service.
VII. The central office of the system; the subordinate stations; their organisation, supply of instruments, &c.
VIII. The staff, their pay, and that of the observers if there is any.
IX. The publications of the central office and the independent publications of the principal stations.
X. The management and inspection of the stations belonging to the system.
XI. Any remarks which may complete the replies already given.
XII. A short historical summary of the system.

The Committee have decided that the replies should refer to the year 1882. Any replies not received before the 1st April 1883 cannot be included in their Report.

We desire to draw the serious attention of Meteorologists to this important subject, and beg you to be good enough to let us know at what date the reply to this circular may be expected.

For the International Meteorological Committee,

H. Wild,
President.
R. H. Scott,
Secretary.

To _____

Note.—In the replies to this circular it will be noticed that none have been received from the Chief Signal Office, Washington, the Central Meteorological Office, Calcutta, or from the British Australian Colonies.

Replies to Circular.

AUSTRIA-HUNGARY.

A.—*Dr. J. Hann, Central Office for Meteorology and Terrestrial Magnetism, Vienna.*

Definition of system.

1. The system consists of volunteer observers under the superintendence of a central office maintained by the State. The number and positions of the stations depend therefore, to a certain extent, upon chance, viz., upon the willingness of new observers to undertake the work. If an observer dies or leaves the station, the observations are generally interrupted.

Number and positions of stations.

2. There are 11 stations of the First Order,
„ 128 „ Second „
„ 94 „ Third „

Total 233 stations.

The stations of the First Order are:—

Eger, 50° 5′ N. lat., 12° 22′ E. long., height 1,493 feet, (with only a self-registering barometer).

Cracow, 50° 4′ N. lat., 19° 57′ E. long., height 722 feet, (with baragraph, thermograph. and anemograph).

Kremsmünster, 48° 4′ N. lat., 14° 8′ E. long., height 1,260 feet, (with barograph, thermograph, and amenograph).

Lesina, 43° 11′ N. lat., 16° 27′ E. long., height 75 feet, (with barograph, thermograph, and anemograph).

Lemberg, 49° 50′ N. lat., 24° 0′ E. long., height 978 feet, (outfit in course of being supplied).

Lobositz, 50° 31′ N. lat., 14° 3′, E. long., height 528 feet, (with thermograph).

Summit of the Obir, 46° 30′ N. lat., 14° 27′ E. long., height 6,713 feet (with thermograph, barograph, also anemograph in future).

Pola, 44° 52′ N. lat., 13° 50′, height 105 feet (with barograph, thermograph, anemograph, and sunshine recorder).

Prague 50° 5′ N. lat., 14° 25′ E. long., height 659 feet, (with barograph, thermograph, anemograph, and self-recording rain-gauge).

Trieste, 45° 39′ N. lat., 13° 46′ E. long., height 118 feet (with barograph, thermograph, and anemograph).

Vienna, 48° 14′ N. lat., 16° 22′ E. long., height 664 feet. (See below.)

Organisation of stations.

3°. Second Order. Kappeller's cistern barometers, with immoveable cistern, dry and wet bulb thermometers, rain-gauges; a few only have special wind vanes.

Third Order. Thermometers and rain-gauges.

The hours of observation are mostly 7h., 2h., and 9h. The instructions are Jelinek's "*Anleitung zu den meteorologischen Beobachtungen*," 2nd edition (Engelmann, Leipzig). A special correction card is supplied with each cistern barometer, in which the corrections for temperature and altitude are combined. For Humidity Tables, those by Wild, issued by Jelinek, are used.

Special observations.

4°. There are none. Since the death of Fritsch, the phenological observations have not been discussed.

Marine observations.

5°. There are none. These will perhaps be organised at the Observatory of the Nautical Academy at Trieste.

6°. This is attended to by a telegraphist and by an assistant of the Central Office. Daily weather charts are drawn and published. In the summer half-year weather forecasts are published for the benefit of agriculture. The telegrams are allowed a reduction of 50% on the ordinary tariff. The cost per month is about 19*s*. Weather telegraphy.

7°. The Central Office of the system is at Vienna and is entitled "*K K Central-Anstalt für Meteorologie und Erdmagnetismus*." The instrumental outfit is stated in the Year-book of the Central Office for the year 1875, Vol. XII., New Series. The Central Office.

The following observations are regularly reduced and published in the Year-books:—Temperature, pressure, wind-direction and velocity, sunshine (in addition to the elements of terrestrial magnetism).

Since April 1872, the observatory of the Central Institute has been situated to the north of the town on a small height surrounded by a garden. The Central Institution serves as a central observatory and a central depository for the observations of the whole system, where they are reduced, calculated and published. The central observatory does not possess any filial stations, unless some of the astronomical observatories and schools can be considered as such, but these are independent of the Central Institute.

8°. A director (salary 280*l*. and addition of 48*l*., with an advancement of salary to 320*l*. and 360*l*. after five years and ten years service respectively.) At the same time he is Professor at the University with the duty of giving lectures in meteorology and physical geography. There is, however, no salary or remuneration for this. Free apartments are provided for him in the building of the Institute. The staff.

Three adjuncts, with salary of 140*l*., and addition of 36*l*. ; after each five years service an advancement of 20*l*. is made. Two of the adjuncts have free apartments in the building of the Institute.

One assistant with salary of 70*l*. and free apartments.
Three computers at 4*s*. a day each.
Three servants, one of whom is only employed temporarily.
One man to attend to the photographic manipulation of the magnetographs, the current mechanical work and the heating.

The total grant to the Central Institution for salaries, outfit of instruments, attendance, &c., amounts in round numbers from 2,400*l*. to 2,800*l*.

The observers receive no remuneration, except those on the summit of the Obir and the Schafberg in winter, and the Schmittenhöhe (at the Zellersee), amounting altogether to 30*l*.

9°. The Central Institute publishes a "Year-book" annually, which contains the daily observations from 18–19 stations, the monthly and yearly results of all the other stations, and the tabulations of the self-recording instruments of the central observatory. Publications.

The stations of Klagenfurt, Trieste, Pola, Prague, and Cracow, publish their observations separately.

10°. The system is managed by the Central Institute in Vienna; the whole of the stations are inspected once every six years by the staff of the Central Institute. The amount voted yearly for this purpose, viz. 30*l*., is not sufficient for the inspection of all stations; so that only the principal stations can be visited. Management and inspection.

11°. Since the year 1871, the Hungarian countries (Hungary, Transylvania, Croatia, and Slavonia) have had an independent system, managed by the Central Office at Buda-Pesth. Supplementary Remarks.

12°. The Austrian system was established in 1848 by the Imperial Academy of Sciences of Vienna. To M. Kreil, the first director, and Baron von Baumgartner, vice-president of the Academy and afterwards Historical.

Minister of Finance, the principal merit for the promotion of the system is due. The scheme for a meteorological service for the Austrian Monarchy will be found in the "*Sitzb. K. Akad. math.-naturw. Classe*," Vol. I. for the year 1848, Section II. Part 3, p. 58, &c., (Vienna 1848).

The Central Office for Meteorology and Terrestrial Magnetism was established in 1851, and commenced operations in September 1852 in a house rented in Favoritenstrasse, Vienna, as a central observatory, and continued there until April 1872, when it was transfered to the new building the "Hohe Warte," situated on the north of the town. The Year-books were first published by the Imperial Academy in 8 vols. for the years 1848–1856 (the first vol. was for 1848–9), then a separate publication was issued by the Academy under the title, "*Witterungs Übersichten*," covering the years 1857—1863, which appeared as a supplement to the *Sitzungsberichte*.

From the year 1864 a new series of the "*Jahrbücher*" was begun by M. Jelinek in a form somewhat smaller than that of the first series. This publication has been published complete up to the year 1879 inclusive, and in addition the first sections for the years 1880 and 1881 have appeared.

B.—*Dr. R. Müller, Hydrographical Office, Pola.*

Sir,

I have the honour to reply to the questions contained in the circular of the International Meteorological Committee, dated 31st December 1882, as regards the station at Pola.

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1°. Austrian system.

2°. Station of the First Order, 44° 51′·8 N., 13° 50′·8 E. of Greenwich.

3°. One Fortin's barometer by T. L. Kappeller as a standard barometer.
One siphon-barometer by Fuess, as a check barometer.
One Wild's electrical registering balance-barometer by Hasler and Escher.
One electrical registering aneroid-barometer by Hipp.
One electrical registering thermograph (dry and wet bulbs) by Hasler and Escher.
One Kew standard thermometer.
One electrical registering thermograph by Hipp.
One dry and wet bulb thermometer.
One recording thermometer by Negretti and Zambra.
Several maximum and minimum thermometers by T. L. Kappeller.
Solar maximum thermometers (black, white, and ordinary bulbs) by Kappeller.
Terrestial radiation thermometer by T. L. Kappeller.
One hygrometer.
One storm glass.
One universal hygrometer.
One weather compass.
} all Klinkerfues'.
One Campbell's sunshine recorder.
One atmometer by Höttinger and one by von Lamont.
One Robinson's self-registering anemometer.
One electrical registering anemometer.
One registering wind-vane.
One registering rain-gauge.

Three rain-gauges (two in the courtyard and one on the roof).
One ozonometer on Dr. Lender's principle.
One tide-gauge.
Two Seismometers.
Two Hipp's clocks and one pendulum-clock for driving the registrating apparatus.

For magnetic observations:—
One declinometer.
One bifilar magnetometer.
One von Lamont's theodolite.
One Jones's magnetometer (under repair).

The regular, direct, meteorological observations are made in the same way as those at the Central Institute, viz., at 7h. a.m., 2h., and 9h. p.m.; at noon also barometer and thermometer readings are made, and the recording thermometer turns over at 2h. a.m.

The direct observations, to serve as standards for the measurement of the curves of the self-recording instruments, are checked at least during the day-time by the head of the department, or by his subordinate officers; the double set of self-recording instruments check each other. Jelinek's tables are used for the reduction of the observations.

4°. The formation and course of thunderstorms are observed as far as practicable. Special observations.

Phenological observations, in a strict sense, are not made.

5°. Regular tidal observations, both direct, as well as by means of tide-gauges. Marine observations.

Meteorological observations are occasionally taken on board ship (beyond the few which are prescribed for safe navigation).

6°. At 7h. am., pressure, wind direction, and force, amount of cloud, readings of dry, wet, maximum and minimum thermometers, rainfall and state of the sea are telegraphed to the Central Office. Weather telegraphy.

From Vienna and Trieste daily weather telegrams arrive for Austro-Hungary, Germany, and the stations on the Adria, as well as the isobar telegrams for Europe.

The station at Pover on the southern point of Istria telegraphs its meteorological observations every morning.

The contents of all these telegrams as well as our own observations are published every morning.

7°. Hohe Warte, Vienna. The Central Office.

8°. The meteorological service is performed by the observatory branch of the Hydrographic Office. This Office, which includes the following branches, observatory, chart depôt, depôt for nautical instruments, and maritime library, is under the superintendence of the above-named director; and the departments in question are under Hydrographic Officers. The staff.

To the chief of the observatory branch (at present temporarily conducted by a naval officer) are assigned one or two naval officers, mostly for the period of a year and a half, also a retired warrant officer as assistant.

The above persons receive fixed salaries.

9°. Monthly and yearly results of observations. These are published in the "Mittheilungen aus dem Gebiete des Seewesens" drawn up by the Hydrographic Office, and are also sent to various institutions and stations, 41 at home and 40 abroad. Publications.

10°. Maintained by the Admiralty. Management.

C.—*Dr. Guido Schenzl, Royal Hungarian Central Office for Meteorology and Terrestrial Magnetism, at Budapesth.*

General Definition.

finition of stem.

1. The Royal Central Office of Hungary is intrusted with the investigation of the climatological and magnetic conditions of the kingdom (including Croatia). Some years ago the Royal Ministry of Agriculture established a special weather office and published daily weather charts and forecasts. The Central Office is only connected with that institution in so far as the latter makes use of the telegraphic reports which are sent to the Central Office. The task of observing, with the exception of the forest meteorological stations and the rain stations mentioned below, is voluntary and without pay, but the instruments are supplied *gratis* by the Central Office.

umber and sitions of ations.

2. There are three stations of the First Order :—

	Height above sea.
1. Budapesth, lat. 47° 30′, long. 36° 42′ from Ferro	502
2. Fiume „ 45° 17′ „ 32° 7′ „	76
3. Agram „ 45° 49′ „ 33° 39′ „	535
Stations for the Second Order in 1882	100
„ „ Third „ „	36
„ „ Fourth „ „	3

ganisation of ations.

3. Outfit of stations of the First Order. *Budapesth.*—In addition to the instruments for regular observations, viz., barometer, dry and wet thermometers, and raingauge, there are in use one Kreil's barograph, one Lamont's thermograph, one Höttinger's self-recording rain-gauge, one Robinson's anemometer. For magnetic observations only the instruments for declination and horizontal intensity are erected, owing to want of space.

The station at Fiume possesses, besides the instruments for stations of the Second Order, van Rysselberghe's universal meteorograph for registering the readings of barometer, thermometer, and hygrometer, direction and force of wind, and rainfall, and also a Seismograph.

The station at Agram possesses, in addition to the ordinary instruments for stations of the Second Order, a self-registering barometer and thermometer by Hipp, an anemograph with printing type, and a raingauge by Otto Schaffler, of Vienna (Osnaghi's pattern), an anemograph by E. Schneider of Vienna, and a Wild's atmometer.

The Agricultural Society of Neutrathal (situated at Nedanócz, lat. 48° 36′, long. 35° 5′, height 507 feet), takes a special position in the system, as, for the purpose of its own agricultural-meteorological objects, it has formed a subsidiary meteorological association. It consists of three stations of the Second Order and one of the Third Order, which also belong to the Central Office, and, in addition, it has 31 stations of the Second Order, which have no connexion with the Central Office. A special service of forecasts is established at the central station of Nedanócz; the warnings are made known by a semaphore.

The outfit of the stations of the Second Order consists of a cistern-barometer by Kappeller, reading to 0·1 mm., dry and wet bulb thermometers ($\frac{1}{5}$° C), one rain-gauge and one wind-vane.

The stations of the Third Order have the same instruments as those of the Second Order except the barometer.

The stations of the Fourth Order only observe rainfall, and, at the special wish of the observer, they receive a thermometer. The number of these stations had increased to 40 at the end of last year.

Hours of observation.—The regular hours of observation are 7h. a.m., 2h., and 9h. pm. Some of the older observers have kept to the hours

formerly in use (prior to 1870), 6, 2, 10; others chose other combinations, *e.g.* 8h., 1h. 8h., a drawback which cannot be helped, in cases where the observers are volunteers.

The instructions used are Dr. C. Jelinek's "Anleitung zur Anstellung meteorologischer Beobachtungen." A short introduction in the Hungarian language gives the necessary explanation to those observers who are not acquainted with German.

The instruments are verified by the Central Office before being issued. The tables for barometer reductions are calculated from Jelinek's formula for Kappeller's station barometers (page 146 of the first edition). The constant errors, which very seldom reach 0·2mm., are not allowed for in the tables, but are applied to the means. For the deduction of vapour tension and relative humidity the tables by Wild and Jelinek are used.

Special observations.

4. Special observations of thunderstorms and hail are not made. Phenological observations are made at 14 stations, and the results are published in the yearbooks. A copy of the form for observations is appended. (Not printed here.)

Marine observations.

5. Nothing is known of these at present.

Weather telegraphy.

6. The Central Office receives daily telegraphic reports of the state of the weather at 7h. am. from 21 home stations. The telegrams are composed according to the following code :—

BBBWW SHTTT $T_1T_1T_1RR$.

B = Barometer reduced to 32° F.
W = Wind direction
S = Windforce.
H = State of the sky
T = Dry-bulb thermometer.
T_1 = Wet-bulb thermometer.
R = Rainfall.

The reduction of the pressure to sea-level is calculated by the formula :—

$$\text{Log B} = \frac{h}{18382\,(1+0\cdot002\,[T+t])\,(1+0\cdot00265\cos 2\varphi)} + \log b$$

To assist in weather predictions the barometer readings reduced to sea-level are posted up, the observers receive special tables for this purpose.

The Central Office.

7. The Central Office is at Buda-Pesth, on the right bank of the Danube. Its operations may be divided into two principal heads.

(*a*.) The establishment, management, and control of the stations, collection and collation of the observations which are received monthly, and correspondence with other central offices.

(*b*.) The work of the meteorological and magnetical central observatory. With reference to (*b*) it must be remarked that the institution does not possess a special building, but since its foundation in 1870, it has been located in a building of very limited dimensions, and all the apparatus which ought to be in operation at a central observatory could not be erected. In addition to the instruments already mentioned under point 3 the following may also be specified.

1 Standard siphon-barometer by Salleron ; 1 standard barometer by Fuess, for verifications ; several Fortin's and siphon barometers and aneroids ; standard thermometers by Dr. Geissler and Fuess, various maximum and minimum thermometers ; evaporators on Lamont's, Greiner's, and Wild's principles ; solar radiation thermometers and actinometer, various hygrometers on Schwaekhöfer's, Regnault's, and Saussure's principles.

The following instruments are in use for absolute observations :— 1 Lamont's declinometer, and 1 declinometer with collimator by Meyerstein, 1 intensity-theodolite by Lamont, a dip-needle by John Dover, and

an earth-inductor by Meyerstein, the whole permanently fixed in houses free from iron. The institution possesses magnetic travelling theodolites by Lamont and Meyerstein, 1 mounted transit instrument, and an equatorially-mounted refractor, several spectroscopes, 1 alt-azimuth free from iron, several reading theodolites, 1 box and 3 pocket-chronometers, an analytical balance by Gambey, a standard metre by Ricker, and other apparatus. There are two sets of earth thermometers, but they are not used for observations.

The staff.

8. The staff of the institution consists at present of a director and two observers, one of whom is a "Privat Docent" at the University. The two observers—one of whom lives at the institute—share the daily work of taking three observations of the meteorological and magnetical instruments, as well as the preparation of the monthly reports for the Year-book. The director undertakes the absolute magnetic observations, the correspondence with the stations and the authorities, the comparison of instruments, the routine and other duties.

The regular salaries are at present—

Director, 210*l.*, with quinquennial increment of 20*l.*

I. Observer, 115*l.*, quinquennial increment of 10*l.*, and residence.

II. Observer, 115*l.*, quinquennial increment of 10*l.*, and 20*l.* for lodging money.

In addition there is one servant employed.

For payment of the telegraph messenger and remuneration of the observers (teachers, telegraph employés, &c.) the sum of 100*l.* is included in the estimates.

Publications.

9. The observations of the stations are published in the year-books by the Central Office; up to the present time nine yearly volumes (1871—1879) have appeared. These contain, in addition to the meteorological results in the prescribed form, magnetical and phyto-phenological observations. In addition, the original observations

(*a*) of Buda-Pesth,
(*b*) of Fiume,

are published monthly.

Management and inspections.

10. The management of the stations and the keeping of the whole of the instruments in proper order, and seeing that they exist, is the duty of the director.

The instruments are, with few exceptions, procured at the cost of the Central Institution or of the Royal Hungarian Office, and remain the property of the same. For this purpose the sum of 200*l.* is included in the estimates every year. The stations are inspected by the Director. From 10—30 stations are visited, according to circumstances, and the instruments compared.

Supplementary remarks.

11. In addition to the publications already mentioned, the following have been published by the Central Office: (1) Contributions to the Meteorology of Buda-Pesth; also printed separately in the Hungarian language. (2.) Meteorological and Magnetical Atlas of Hungary prepared on the occasion of the Geographical Exhibition at Venice, and containing 26 charts. (3.) Contributions to terrestrial magnetism in the countries of the Hungarian Crown. Absolute Determinations of the Magnetic Elements at 126 Stations in the years 1864—1881, by Dr. Schenzl, published by the Royal Hungarian Society of Natural Science.

Historical.

12. The history of the Royal Hungarian Central Office will be found in the first volume of the Year-book; I shall only mention the most important points here.

Meteorological observations were made in Hungary in the last century. We find among the stations of the *Societas Palatina* in the year 1781 Ofen (Buda) already represented.

In the present century we find fragmentary observations—those at the observatories then existing at Erlau, Klausenburg, and Carlsburg (Transylvania), partly made by private persons. The longest series were made at the observatory at Ofen, with a few interruptions, from November 1781 till the destruction of the observatory in May 1849, at which time many registers were lost. The observations made by the astronomer Dr. Lambert Mayer and his coadjutor F. A. de Montedegó, from 1841 to 1848 were published by the Hungarian Academy of Sciences. The Central Meteorological Institute established in the year 1851 at Vienna formed the central point about which numerous observers from Hungary, Transylvania, Croatia, and the Military Frontier soon gathered. Their number increased to 31 in the year 1860. A great falling-off took place in consequence of the political movement in the year 1861, which lasted until the year 1863, and the number of observers in Hungary sank down to 11.

In the year 1861 the undersigned established an observatory at the Ofen *Realschule*, which included observations of the magnetic variation in addition to those of atmospherical phenomena. This was afterwards made the Academic Observatory, and was provided by the Academy with complete magnetical and some astronomical apparatus. The interest which the Academy took in the scientific investigations of the country caused a continually growing interest in the subject of meteorology, and the number of observers rose to 44 in the year 1869. All these sent their observations, for the want of an institution at home, to the Austrian Central Office.

When the Hungarian Constitution was again restored, in 1867, the arrangement which had existed until then could not continue, therefore the Royal Hungarian Ministry of Worship and Instruction, on the proposal of the Academy, resolved to establish an independent Central Office for the countries of the Hungarian Crown ; the Royal Sanction was obtained on the 8th April 1870. The conditions at that time were not favourable for the development of the new institution ; it received a severe blow in February 1871 by the death of its founder, the Minister Baron Eötvös.

Although in the scheme for the organisation of the staff, a director, one adjunct (meteorologist), two assistants, and an auxiliary staff which could be increased when necessary, were provided for, it has not hitherto been possible to obtain the appointment of another assistant, although the number of stations has increased fourfold since the foundation of the institution. That the Central Office, under such conditions, is not in a position to undertake special investigations, beyond the current and actually indispensably necessary observations, is evident. A considerable increase of work is thrown upon the Central Office by a large portion of the observers not reducing and calculating their own observations, but leaving this to the Central Office. The want of a suitable building for special meteorological observations has already been mentioned.

BELGIUM (*a*.)

M. Houzeau, Royal Observatory, Brussels.

Definition of system.

1°. The meteorological system of Belgium is under the superintendence of the Royal Observatory of Brussels, where all the observations are centralised, reduced, and published.

Number and positions of stations.

2°. It is composed of one station of the First Order, the Royal Observatory, lat. 50° 51′ N., long. 4° 22′ E., with 40 stations of the Second Order, and 39 stations of the Third Order. The Administration *des Ponts et Chaussées* has also established 122 rain stations, from which the registers are sent to the Observatory and are published by it. The thunderstorm stations number 72, but among these are a large number of stations of the Second and Third Orders which have included the systematic observation of thunderstorms in their programme.

The Résumé,—There are 41 stations which observe atmospheric pressure, temperature, and humidity, with the direction and force of wind.

80 stations observe the amount of cloud and occasional phenomena, with general remarks about the state of the weather.

202 stations observe rainfall.

72 stations systematically observe thunderstorms.

Organisation of stations, &c.

3°. The hours of observation everywhere are 8h. a.m. and 1h. p.m. Rainfall is only observed once a day, at 8h. a.m. At the Brussels Observatory the hours of observation are naturally more frequent; complete observations are made at 9h. a.m., noon, and 0h. 26m. p.m. (The synchronous observation), 3h. and 9h. p.m.; temperature is also observed at 10h. a.m., 2h. and 4h. p.m.

Printed instructions issued by the Observatory are supplied to all observers; they contain the necessary reduction tables. The observations are checked by annual inspection of the stations, and by the examination, at Brussels, of the registers as they are received from the observers.

Special observations.

4°. Phenological observations have been somewhat neglected in recent years, but they are to be resumed shortly. Three or four stations only still pay attention to this kind of research.

Marine observations.

5°. For nearly two years (1879 and 1880) observations were made on board the Belgian mail-packets running between Ostend and Dover, but these have been abandoned. Latterly complete stations of the Second Order have been established on the lightships of Westhinder and Wielingen off Ostend and Flushing. These stations work in a regular manner.

Weather telegraphy.

6°. The Observatory receives the following telegraphic reports daily for the construction of its meteorological bulletin:—

1°. 3 Belgian stations: Furnes, Maeseyck, and Arlon.

2°. 4 Dutch stations, from Utrecht.

3°. 9 French stations, from Paris.

4°. 5 English stations, from Hamburg.

5°. 8 German stations, from Hamburg.

6°. 5 stations for northern countries, from Hamburg. Occasionally we receive from Amsterdam reports from two or three English stations. Lastly, we receive, directly from the "New York Herald" Office in London, the storm-warning notices issued by that journal.

The Observatory, on its part, sends daily telegrams to Paris, London, and Hamburg; and in this country to seaports and fishing stations.

(*a*) See also App. XII., p. 115.

When a rapid fall in the barometer manifests itself, warning telegrams are also sent to the Administration of Mines.

The Central Office, &c.

7°. Neither the Central Institute nor the Royal Observatory has any branch offices; an observatory is now being established at the University of Liége for astronomical and meteorological researches, but this establishment will be quite independent of the Brussels Observatory. The latter has naturally always in reserve a certain number of instruments for stations of the Second and Third Orders, such as barometers, thermometers, rain gauges, &c.

The Observatory possesses a collection of the following self-registering instruments :—

1°. Van Rysselberghe's electrical meteorograph.
2°. „ telemeteorograph (in operation between Ostend and Brussels).
3°. Photographic self-recording instruments, Kew pattern (for meteorology and magnetism).

All these instruments work regularly.

The staff.

8°. The staff of the system is composed of professors, teachers, clergymen, engineers, agriculturists, manufacturers, &c. These persons are not remunerated.

The staff at the Observatory for meteorological service comprises :—

		£	£
1 Chief of service - - -	salary	200 —	240
1 Meteorologist, Inspector - -	„	140 —	180
1 Meteorologist - - - -	„	140 —	180
1 Adjunct - - - -	„	100 —	120
1 Assistant - - - -	„	48 —	96

Publications.

9°. The essentially meteorological publications of the Observatory are :—

1°. *The Annales* (comprising the observations made at the Observatory and at all the stations).
2°. The meteorological bulletin (weather charts).
3°. The curves of van Rysselberghe's self-registering apparatus.

Some observers at the stations of the Second Order publish abstracts of their observations in the newspapers of the localities in which they live.

Management and inspections.

10°. As above stated, all the stations, with the exception of those established by the *Ponts et Chaussées*, are under the superintendence of the Royal Observatory. They are inspected every year.

Supplementary remarks.

11°. A great number of particulars relative to the organisation of the meteorological service in Belgium have already appeared in the various Reports of the Congresses or the International Meteorological Committee (*see* Appendix XII. to this Report). These particulars are only intended to complete them.

Historical.

12°. The organisation of the present meteorological service dates from the year 1877. It has been extended and developed each year.

The late M. Quetelet had organised a system of several stations, the observations of which have been published in the memoirs of the Belgian Academy. But the control of the Observatory over these stations was not sufficiently direct. The majority, however, were carried on by educated and conscientious observers.

DENMARK.

Captain N. Hoffmeyer, Danish Meteorological Institute, Copenhagen.

Definition of system.

1. The Danish meteorological system embraces the kingdom of Denmark, the Faroe Islands, Iceland, and Greenland. It is organised and managed by the Danish Meteorological Institute, which is a Government institution, under the Ministry of Marine.

Number and positions of stations.

(2.) 1 Station of the First Order :—

Vamdrup in Jutland, lat. N. 55° 25′, long. E. 9° 18′.

Stations of the Second Order :—

Denmark.	Faroe Islands.	Iceland.	Greenland.	Total.
10	1	5	5	21

Stations of the Third Order :—

171	7	18	10	206

Organisation of stations.

3. At the station of the First Order (Vamdrup), pressure, temperature, humidity, and the direction, and force of wind are observed every two hours ; the maximum and minimum temperature and rainfall, once daily. The stations of the Second Order observe all the ordinary meteorological elements three times a day (8 a.m., 2 and 9 p.m.) The stations of the Third Order generally observe temperature and rainfall ; some of them observe temperature only, and others only rainfall. Observations of wind, weather, sea disturbance, and floating ice are made at 28 lighthouses five times in the 24 hours.

The Instructions which are supplied to the observers are not published. The reduction tables used are those by M. Jelinek. The observations are carefully checked before calculation, and the results are finally compared by the construction of diagrams and of mean synoptic charts for each month.

Special observations.

4. There are no special observations.

Marine observations.

5. Maritime observations are made regularly at 17 fixed stations (lightships, &c.) in the seas surrounding Denmark, and include, besides the meteorological elements (at four-hourly intervals), the direction and rate of currents, the temperature and specific gravity of the sea at the surface, and at different depths down to the bottom.

The Institute also receives a large number of maritime observations made by vessels traversing the North Sea, and the northern parts of the Atlantic, on the voyages to Iceland and Greenland. These observations are entered into squares of one degree of latitude by one degree of longitude.

Weather telegraphy.

6. The Institute receives telegrams every morning containing the 8 a.m. observations from 10 of its own and from 26 foreign stations. Synoptic charts are drawn for the previous evening and for the morning, and show the variations of the elements. At 1h. 30m. p.m. a report of the actual state of the weather in the North of Europe and the probable weather for the next day is drawn up. This report is sent to the newspapers of the Capital, and is transmitted by the Government to all the telegraph stations of the country, where it arrives before 3 p.m.

The Central Office.

7. The Central Institute of the system is at Copenhagen, and there is no filial institution.

The principal instruments belonging to the Institute consist of 45 barometers, 910 thermometers of different kinds, 112 rain gauges, 120 hydrometers, and 31 anemometers. A considerable number of the instruments used at the stations are private property, and these are not included in the above list.

8. The staff of the Central Office is composed of :— The staff.

1 Director, salary 224*l.* and apartments.

3 Sub-Directors (for climatology, weather telegraphy, and ocean meteorology), salary 112*l.* to 128*l.*

1 Librarian, salary 32*l.*

Computers, Draughtsmen, &c., 220*l.*

All the observers at stations of the Second Order (both in the kingdom and the colonies) receive at least 7*l.* a year, and the observers at the maritime stations get from 2*l.* to 3*l.* a year. Captains of vessels are recompensed in various ways by presents of aneroids, telescopes, publications, &c.

9. The Institute publishes :— Publications.

(*a.*) Daily Weather Charts (a small number is produced by the manifold process, but they are published by the newspapers).

(*b.*) Very detailed monthly reports, with diagrams and mean charts.

(*c.*) Annals.

The publications (*b.*) and (*c.*) are supplied free to all the observers.

10. In the kingdom itself the stations of the Second Order are inspected every year by one of the staff of the Institute ; the stations of the Third Order are inspected in turns. In the colonies the stations are inspected by vessels of war, as opportunities present themselves. The Institute possesses sketches and descriptions of all the stations. Management and inspections.

11. No remarks to add. Supplementary remarks.

12. Meteorological observations have been made at Copenhagen since the middle of the 18th century, under the auspices of the Royal Society of Sciences. In 1861 the Royal Agricultural Society organised a system of meteorological stations all over the country, several of which are still in existence. The Meteorological Institute was established in 1872, and from that time the number of stations in the kingdom has gradually increased, and at the same time many stations have been established in the colonies (Faroes, Iceland, and Greenland). The maritime observations were first commenced in 1879. Historical.

FRANCE.

Professor E. Mascart, Central Meteorological Office, Paris.

1°. Central Meteorological Office, under the Ministry of Public Instruction.

2°. Stations of the First Order :— Definition of system.

Park of St. Maur, lat. 48° 48′ 28″ N., long. 0° 0′ 36″ E., alt. 152 feet (Paris.) Number and positions of stations.

Nantes, lat. 47° 13′ N., long. 3° 53′ W., alt. 136 feet.

Puy-de-Dome (two stations)—

Station on the plain, lat. 45° 46′ N., long. 0° 45′ E., alt. 1,273 feet.

Summit of the mountain, lat. 45° 47′ N., long. 0° 37′ E., alt. 4,813 feet.

Pic du Midi, lat. 42° 56′ N., long. 2° 12′ W., alt. 9,377 feet.

Perpignan, lat. 42° 42′ N., long. 0° 34′ W., alt. 98 feet.

The observatories of Lyons and Bordeaux are both meteorological and astronomical, and possess self-recording instruments.

A private station, St. Martin de Hinx, established and superintended by M. Carlier, possesses a complete set of self-recording instruments, and may be considered as a station of the First Order.

The observatories of Marseilles and Toulouse make observations six times a day, and possess some self-recording instruments.

There are 73 stations of the Second Order, at normal schools, 43 of which make six observations, and 30 three observations daily.

There are more than 1,500 stations of the Third Order, at which rainfall is observed.

In addition there are 16 stations of various kinds.

Organisation of stations.

3°. The staff of the stations of the First Order consists of a director, two assistants, and one attendant.

The hours at which direct observations are made are generally 6 and 9 a.m., noon, 3, 6, and 9 p.m.

The stations of the Second Order observe at the same hours, or at 6h. a.m. noon and 9h. p.m.

The stations of the Third Order generally observe at 9h. a.m.

The Instructions supplied are those published by the Central Office in the form of a pamphlet.

The observations are checked on their arrival at the Office, and are compared with each other. Doubtful or erroneous observations are at once notified to the observers.

Special observations.

4°. Observations of thunderstorms are made at a great number of stations (about 3,500).

The telegraphic administration sends to the Central Meteorological Office a return of the disturbances produced by atmospheric electricity.

The Hydrological and Forest Departments also observe thunderstorms at about 900 stations.

Phenological observations are made at 1,500 stations, and the number increases every year.

Marine observations.

5°. The vessels of war, and a great number of merchant ships make simultaneous observations, corresponding to those of the United States Signal Office, viz., at 4h. 18m., 12h. 18m., and 8h. 18m. mean Paris time.

The observations made on board merchant ships are collected at the principal ports by a special staff, which also undertakes the comparison of instruments.

Weather telegraphy.

6°. The telegraphic weather service consists:—

(1.) Of the receipt of observations from international stations which form the basis for the construction of the charts of the International Bulletin. The observations are published in the same bulletin.

(2.) Of the transmission of forecasts to the ports.

(3.) Of the transmission of agricultural forecasts to communes which have subscribed for them.

(4.) Of the transmission of storm warnings to the Ministry of Marine.

The telegrams for the ports, the bulletin and the weather charts are drawn up by the branch for weather telegraphy.

The Central Office.

7°. The staff of the Central Meteorological Office consists of a director, three heads of service, and of adjuncts and assistants.

It has the assistance of a Council composed of delegates of various ministries, and of the Academy of Sciences. This council meets every three months.

The Director calls a meeting of the heads of service every month, at which scientific questions and matters relating to the progress of the service are discussed.

The Central Meteorological Office is divided into three distinct branches:—

1°. Warnings to sea ports and for the benefit of agriculture. This branch draws up forecasts and the daily weather reports, and discusses the thunderstorm observations and the forecasts.

2°. Climatology. This branch is charged with the organisation and superintendence of the stations and observatories, undertakes the inspections and publishes the meteorological observations and various memoirs bearing more particularly upon climatology.

3°. General meteorology. This branch is charged with the organisation of observations at sea, at the Consulates, and in the French colonies, and studies more especially general meteorological questions.

The instruments used are too numerous to be described here; those in general use are described in the Instructions of the Central Office.

The staff.

8°. Only the observatories or stations of the First Order have a paid staff; the observers at other stations mostly belong to public services and observe gratuitously. At stations of the Third Order in certain cases some remuneration is granted by the Meteorological Commissions.

The staff of the Central Office consists of titular meteorologists with salaries varying from 120*l.* to 400*l.*; adjuncts, 100*l.* to 200*l.*; assistants, 48*l.* to 100*l.*

Publications.

9°. The Central Office publishes every year the Annals of the Central Meteorological Office, in four volumes:—

Vol. I. *Etude des orages en France et Memoires divers*, including memoirs on the weather service, on thunderstorms, and on questions relating to weather forecasts, as well as papers by meteorologists, whether they belong or not to the office.

Vol. II. *Observations Françaises et Revue Climatologique.* This volume contains, as its name indicates:—

1°. The details of the observations from the observatories of the First Order and from a certain number of stations of the Second Order in France and Algeria, and a *resumé* of the observations of the stations of the First and Second Orders, a climatological review with charts, in which the principal characteristics of each month in the West of Europe are discussed.

Vol. III. *Pluies en France.* This volume contains the detailed observations of rainfall in France for a large number of stations, and a *resumé* of the observations for other stations which have not found a place in the detailed tables. A general *resumé*, with discussions of wet periods and charts of the distribution of rainfall, accompany the volume.

Vol. IV. *Météorologie générale.* This volume contains discussions on the distribution of the meteorological elements over the surface of the globe and memoirs upon general subjects. From the year 1882 it will also contain observations from the Consulates and from French colonies.

Management and inspections.

10°. The office is managed by the director, with the assistance of a responsible secretary. The stations are inspected either by the director, by the head of the climatological service, or by one of the staff, charged with a temporary mission.

Supplementary remarks.

11°. The Central Office is in permanent relation with the Meteorological Commissions. The latter, which are nominated in each department by the Prefect, are composed of engineers, professors of sciences, and persons more particularly interested in meteorology. These Commissions organise the thunderstorm observations in the departments and direct in general all the meteorological work of their districts.

Their delegates attend a general meeting of the council of the Central Meteorological Office, which takes place once a year, for the purpose of examining the progress and the requirements of the Commissions. The Central Office supplies instruments to the Commissions.

The Commissions have funds provided either by the local administrations or by persons interested in the science. A large number of them publish bulletins of their operations.

Historical.

12°. The study of meteorology in France was first organised by Leverrier at the Paris Observatory. Some months after the death of Leverrier the decree of the 14th May 1878 constituted a distinct service for meteorology under the title of the Central Meteorological Office.

GERMAN EMPIRE. A.—BAVARIA.

Dr. v. Bezold, Royal Central Meteorological Station of Bavaria, Munich.

Definition of system.

1. The Royal Central Meteorological Office of Bavaria at Munich is entrusted with the duty of collecting meteorological observations in the kingdom of Bavaria; and it examines and prepares them for publication. Generally speaking it serves as a centre for all observations in the domain of meteorology, excepting forest meteorology.

Number and positions of stations.

2. At present there are 36 stations under the Central Office. These have been fitted out and are maintained at Government expense. They are called "normal stations." There are, however, in connexion with them, the Royal Observatory of Bogenhausen near Munich, as far as the meteorological and magnetical observations carried on there are concerned, and 10 other stations which are subordinate to the Central Office as regards the testing of their instruments, the supply of forms, &c., though not financially. These are called "supplementary" stations. The stations are classified as follows:—

(*a*) Two stations of the First Order. (1) The Royal Bogenhausen Observatory near Munich, lat. 48° 9′, long. 11° 34′, height above sea, 1,735 feet. (2) Kaiserslautern, lat. 49° 27′, long. 7° 46′, height above sea, 794 feet.

(*b*) Twenty stations of the Second Order, viz. 15 normal and 5 supplementary stations.

(*c*) 23 stations of the Third Order: 18 normal and five supplementary stations.

Organisation of stations.

3. Bogenhausen possesses the well-known self-registering instruments left by Lamont. Kaiserslautern has a self-registering anemometer of the same kind as that in use at the *Deutsche Seewarte*, a Hipp's thermograph and a barograph by the same maker, and in addition, the complete outfit of a station of the Second Order.

The stations of the Second Order have the following instruments.

1. Barometers, mostly station barometers with reduced scales, by R. Fuess of Berlin; a few have Fortin's barometers by Pastorf and Lenoir of Vienna.

2. Dry and wet bulb thermometers and minimum thermometers in a screen. Many of the stations have double louvres placed on the sides of the screen.

3. A couple of rain-gauges.

4. A Koppe's hair hygrometer.

5. A few stations have wind vanes or pennons.

The stations of the Third Order have,

1. Maximum and minimum thermometers and check thermometers, mostly in double sets.

2. A couple of rain-gauges.

The hours of observation at the stations of the Second Order are 8 a.m., 2 a.m. and 8 p.m.; at the stations of the Third Order 8 a.m. and 8 p.m. Observations are made according to the "Instructions for observers at Meteorological Stations in the Kingdom of Bavaria," published by the Royal Bavarian Central Meteorological station at Munich (Munich 1878, T. Ackermann).

The tables used are found in those Instructions as well as in Volume I. of the "Observations in the Meteorological Stations of the Kingdom of Bavaria."

The registers received monthly from the stations are carefully checked between the 2nd and 10th of each month at the Central Office, both numerically and graphically. The stations are also inspected from time to time and the instruments verified there.

Special observations.

4. Apart from the observations of the regular meteorological stations, there is a great number of volunteer observers distributed over the whole country who send to the Central Station observations of thunder-storms, hail, and of special atmospheric phenomena. The total number of stations which sent communications of this nature amounted to 252 in the year 1882. These communications are written on cards provided for this purpose, and are sent in immediately after the observations. In the year 1882, 4,701 such cards were received, of which 4,162 contained reports of thunder, the rest reports of sheet-lightning only.

Weather telegraphy.

6. The Central Station receives telegrams from three of its own stations, and also from the *Deutsche Seewarte* and the Central Meteorological Office at Vienna. These telegrams contain reports from 50 stations embracing the whole of Europe, with the exception of the Pyrenean and Balkan peninsulas. Four telegrams are sent to the *Deutsche Seewarte*. The Central Office sends a collective telegram to Vienna, whence it is forwarded to Italy. Two weather reports are prepared from the telegrams received daily at the Central Office, a morning report, which contains only the observations from four Bavarian stations and a summary based principally upon the telegrams of the previous day, regard being paid to the inland telegrams received soon after 9 a.m. This morning report is inserted in two Munich papers. In the afternoon a weather chart is issued with the report and manifold copies are made. It contains together with the isobaric chart (printed in black on blue ground) the morning observations from 42 stations as well as a summary of the weather, as complete as can be made, and a forecast for the next day and for the different climatic districts of the kingdom. The forecasts are distributed by telegraph, according to a code of from one to three groups of letters. The groups have reference to the different climatic districts of the country. The first letter of each group refers to the wind, the second to the clouds, the third to rainfall, the fourth to temperature, and the fifth contains general remarks. These forecasts can be subscribed for at each Bavarian telegraph station. The subscription is 2*s*. a month, 8*s*. a quarter, and 15*s*. a half year. Each subscriber receives the key for converting the telegrams. The telegraphic administration undertakes entirely the distribution of these telegrams. The latter receives the noon report from the Central Office about 4h. p.m. The Weather Chart is issued about 5h. p.m.

The Central Office.

7. The Central Office is directly under the ministry for Church and School affairs. It is at Munich, but has no special building. Its

outfit, therefore, scarcely corresponds to a station of the First Order, and its observations are only published as those of a station of the Second Order.

The staff.

8. The staff of the Central Office consists of a Director, who carries on that duty at the same time as his work as a Professor.

	£
His salary is - - -	150
One adjunct (salary) - - -	150
One assistant „ - - -	75
Two „ (each) - - -	60

and a man servant.

The accounts are managed by the accountant of the Royal Academy of Sciences. The observers of the regular stations (the normal stations) receive remuneration as follows:

	£ s. £
Stations of the Second Order - -	12 10 to 15
Stations of the Third Order - -	6

The total cost of the meteorological service in Bavaria is, so far as the public funds are concerned, 782*l.* for salaries, &c., and 388*l.* for expenses; total 1,170*l.* a year.

There is an addition from an agricultural fund of 180*l.* for the weather forecasts.

Publications.

9. The Central Office publishes the daily observations of all the normal stations as well as monthly and yearly summaries in a work entitled, *Beobachtungen der meteorologischen Stationen im Königreich Bayern, herausgegeben von den Centralstation durch Wilhelm von Bezold und Carl Lang.*

The work appears quarterly and contains, besides the above-mentioned observations of all the normal stations, those on thunderstorms in Bavaria and Württemberg (the observations of these phenomena in Württemberg are sent monthly for discussion from the Central Office at Stuttgart) as well as older observations made in Bavaria. The fourth volume of this work is now in the press. The Central Office also publishes monthly the "*Übersicht über die Witterungsverhältnisse in Bayern*," for the preceding month.

These monthly summaries appear first in a newspaper (the *Augsburger Abendzeitung*) and are then separately printed for distribution by the Central Office. The "Weather Charts and Weather Reports" which are issued daily have been already mentioned.

Management and inspections.

10. The Central Office undertakes the management and inspection of the stations.

Historical.

12. The meteorological service in Bavaria was established in 1878. The Central Office began work on the 1st October 1878. The stations, after three months' practice, began regular observations on the 1st January 1879. Some of them had been previously established at the cost of local authorities, &c., or by private persons, and had already been working for some years. These were simply incorporated in the system but their outfit was completed.

The Central Office issued telegraphic weather reports in the course of the first year, and actual weather forecasts were begun on 1st April 1881.

GERMAN EMPIRE. B.—HAMBURG.

Dr. G. Neumayer, Deutsche Seewarte, Hamburg.

Introduction.

The meteorological service in the German empire is carried out by different systems, which are connected with each other and which are limited by the political divisions. The organization of the *Deutsche Seewarte* is the only one which is imperial, and it is the central office for maritime meteorology and for weather telegraphy. In this respect the domain of the *Seewarte* extends over the whole empire.

The other systems, which, although independent of it, yet work in harmony with it and each other, are:

1°. The meteorological system for the Kingdom of Prussia, and the smaller states, which are connected with it as regards their meteorological work.

2°. The meteorological system for the Kingdom of Bavaria.
3°. „ „ „ Saxony.
4°. „ „ „ Württemberg.
5°. „ „ Grand Duchy of Baden.
6°. „ „ Imperial Provinces of Alsace-Lorraine.

Presuming that the directors of the separate systems have replied to the circular of the International Meteorological Committee respecting meteorological organizations, which has been ascertained by a circular issued by the member of the committee for Germany, this paper will only refer to the organization of the *Deutsche Seewarte* and of the branches connected with it. The meteorological organization of the Grand Duchy of Baden and of the Imperial Provinces will only be touched upon in a general way, as special reports of these have not been sent in.

It must here be remarked that the directors of the different central meteorological offices in Germany are accustomed to hold conferences on all questions of importance, the decisions of which are binding on the separate systems and are accepted as regulations in the organizations of the separate countries.

The system of the Deutsche Seewarte at Hamburg.

Definition of system.

1. As is seen from the Introduction, the system of the *Seewarte* with respect to maritime meteorology embraces the whole German empire. With regard to weather telegraphy we must make a distinction between storm warnings and inland weather forecasts. The first are entirely under the control and management of the Seewarte, and extend to the whole of the coast, from the Russian frontier in the east to the Dutch frontier in the west. The latter, the weather service, is, on the contrary, carried on by the systems of the different States for themselves, but in dependence on the Institute of the Seewarte. It consists in the first place of the receipt of the greater part of the foreign observations employed in the weather service, which are partly in their original form and partly as results, in the shape of synoptic charts and forecasts.

2. The system of the *Deutsche Seewarte* comprises nine normal stations, which may be considered as stations of the First Order.

umber and sitions of ations.

The following are the names and geographical positions of these stations:—

1. Hamburg,	lat. 53° 33′ N.,	long.	9° 58′ E.,	altitude	66	feet.
2. Memel,	„ 55° 43′ N.,	„	21° 7′ E.,	„	13	„
3. Neufahrwasser,	„ 54° 24′ N.,	„	18° 40′ E.,	„	13	„
4. Swinemünde,	„ 53° 36′ N.,	„	14° 17′ E.,	„	20	„
5. Wustrow,	„ 54° 21′ N.,	„	12° 24′ E.,	„	23	„
6. Kiel,	„ 54° 20′ N.,	„	10° 9′ E.,	„	154	„
7. Keitum,	„ 54° 54′ N.,	„	8° 22′ E.,	„	30	„
8. Wilhelmshafen,	„ 53° 32′ N.,	„	8° 9′ E.,	„	36	„
9. Borkum	„ 53° 35′ N.	„	6° 40′ E.,	„	13	„

Here some stations of the First Order may be named which belong neither to the above-mentioned meteorological systems nor to the *Seewarte*. They are independent, but send contributions to the reports of the *Seewarte*.

These stations are:—

1°. Magdeburg, lat. 52° 9′ N., long. 11° 37′ E., altitude 177 feet.

This station has been established by the proprietors of the "*Magdeburger Zeitung*," and is called the *Wetterwarte der magdeburger Zeitung*, and is maintained by the same.

2°. Frankfort o/M., lat. 50° 8′ N., long. 8° 41′ E., altitude 338 feet.

This station has been established by the Physical Society of Frankfort, and is maintained as its station.

3. Kaiserslautern, lat. 49° 27′ N., long. 7° 45′ E., altitude 794 feet.

This station was established by the funds of the Palatinate, and is maintained by it in the Royal Polytechnic School.

The system of the *Seewarte* has, in addition to the above-mentioned stations, which take the same observations as stations of the First Order, two supplementary stations, with an outfit like stations of the Second Order, and which also take similar observations, viz., Cuxhaven and Rügenwaldermünde on the Pomeranian coast.

It must here be mentioned that the Seewarte receives observations from stations of the Second Order, partly for the purposes of weather telegraphy, partly for publication according to the international scheme, as may be necessary. The details about these stations are to be found in the reports of the respective systems.

With regard to the number of stations of the Second Order, it is to be remarked that the Coast Signal Stations, 45 in number, are fitted out as stations of the Third Order, and should therefore be counted as stations of this kind belonging to the different systems in the districts in which they lie. If therefore an idea is to be formed of the number, proximity, &c. of the stations of the Third Order, the reports of the *Seewarte* and those of the different systems must be consulted.

anization of tions.

3. The outfit of the stations of the First Order belonging to the *Seewarte* the (normal observing stations) may be seen from the details given in the First Annual Report upon the organization and operations of the *Deutsche Seewarte* in "*Aus dem Archiv der Deutschen Seewarte*," first year, 1878, pp. 33–4, as well as from No. 2 of the same work, "*Instruktion für den meteorologischen Dienst der Deutschen Seewarte*," pp. 5–16.

Respecting the hours and methods of observation, as well as the keeping of the meteorological registers at the stations of the *Seewarte*, the necessary information will be found in the same work, "*Instruktion*, &c." pp. 17–23, and in the instructions for signal stations, pp. 18–20. No change has been made since the publication of that information.

For the reduction of the observations the tables compiled by the

Seewarte are used; for the reduction to sea-level those published by Dr. C. Jelinek are generally used.

The observations are constantly checked at the *Seewarte*. Department III. of this institution has a special employé, whose duty it is to check and collate the observations, and this officer inspects the stations. The method of examination is in its details different for the stations of different orders, according to the matter to be dealt with, but it is essentially the method generally adopted, and therefore it is unnecessary to go into further explanations.

4. With respect to this question it is to be observed that the system of the *Deutsche Seewarte*, as already mentioned, has to deal specially with storm warnings, and that climatological researches scarcely form one of its objects, as these are attended to by the different systems of meteorological investigation in Germany. Therefore we can only repeat here, what has been already said about stations of the Second Order; the work of the *Deutsche Seewarte* with respect to climatological research in Germany can only be regarded as supplementing the arrangements of the separate systems. Special observations.

Observations of thunderstorms and hail are made at all the signal stations on the coast, and they report these phenomena immediately after their occurrence to the Central Office at Hamburg by means of specially prepared cards (as in Bavaria and Württemberg). It will be seen from what has been said that phenological observations do not form part of the working plan of the *Seewarte*. These are occasionally made by private persons in Hamburg and other places, and sent to the *Seewarte*.

5. The organization of maritime meteorological observations, in strict accordance with the decisions of the International Meteorological Conference held in London in 1874, has been carried out since 1876 in considerable detail. Marine observations.

The yearly reports of the *Deutsche Seewarte*, from 1875–1878, 1879, and 1880, give all the necessary information as to the arrangements and the different points determined upon, as well as about the historical development of maritime meteorology in Germany. These yearly reports are contained in "*Aus dem Archiv der Deutschen Seewarte*," in Nos. 1, 3, and 1 of the yearly vols. I., II., and III.

The following is a brief sketch of the condition of maritime meteorology at the *Deutsche Seewarte* at the end of the year 1882. Agencies have been established along the coast, on the one hand, to awaken interest for meteorological work in the ports of the German coast, and on the other to simplify the distribution and examination of registers and instruments, and to spread as far as possible the benefits which navigation may derive from this investigation. These agencies are divided into principal agencies, which are provided with everything necessary for testing instruments (and especially the determination of Deviation on board iron ships). These principal agencies are at Bremerhaven, Swinemünde, and Neufahrwasser. The outfit and organisation of these principal agencies, as well as the agencies to be mentioned directly, may be learnt from the above-mentioned yearly reports. The *Deutsche Seewarte* has 11 agencies on the coast, in addition to those already mentioned.

In order to further this part of the efforts of the *Deutsche Seewarte* abroad, the German General Consulates and Consulates are provided with registers, which are issued to captains at their request, and they co-operate with the institution by returning the registers above mentioned, by distributing publications to seamen, &c.

Captains, at their request, are supplied with sailing directions prepared

for certain routes, special attention being paid to modern views of meteorology and less to mere statistics. The number of sailing directions issued gradually decreases in proportion as the number of publications of the institution increases. The issue of a work, "The Pilot," a guide for sailing ships, has been especially beneficial in this respect; two volumes of this work have already appeared, and the third is in the press. Also the various articles on maritime meteorology and ocean tracks in the "*Annalen der Hydrographie und maritimen Meteorologie*" may be mentioned here. A sailing Handbook for the Atlantic Ocean is also in the press.

In order to form an idea of the extent of the materials available, the following figures will be useful:—

In 1882, the first section of the *Seewarte*, received complete meteorological registers from 221 sailing ships and 79 steamships, altogether 300 in number, in addition to 43 from ships of war.

206 extracts from logs were received and were used chiefly for the synoptic work of the North Atlantic Ocean. These contain observations made at 8 a.m. and 8 p.m. (but only from ships supplied with mercurial barometers), while the complete logs contain observations six times a day, at the hours agreed upon at the International Conference.

The contents of all the logs received in the year 1882 may be gathered from the following round numbers:—

The 300 complete logs of the Mercantile Marine contained 1355 months = 247,890 sets of observations.

The 43 complete logs of the Navy contained 189 months=34,670 sets of observations.

The 206 extracts of the Mercantile Marine contained 178 months= 10,880 sets of observations.

Altogether, therefore, the maritime observations collected by the first section of the *Seewarte* in 1880 amounted to 1,722 months=293,440 sets of observations.

It must be remarked that this extensive material is spread over all the commercial routes of the ocean, and that it is of the first quality. Ordinary logs containing observations made, not with the instruments of the *Seewarte*, but with instruments tested at the *Seewarte*, are excluded from the collection and discussion.

The material is used in three different ways:—

1. Extracts are made of meteorological observations, and matters interesting to navigation are extracted from the ships' logs of all voyages, and are at once published in the *Annalen der Hydrographie und maritimen Meteorologie*.

2. The results of the observations combined with those made on board Dutch ships are arranged in climatological and general meteorological tables and published in one-degree squares for each month.

3. The *Deutsche Seewarte* constructs synoptic charts for the N. Atlantic Ocean and for each day of the year from the ships' observations. There are, on an average, from 50 to 55 observations for 8 a.m. for different positions available.

A strict check on the observations is carried out by means of this synoptic work.

The Danish Meteorological Institute and the *Deutsche Seewarte*, by means of this material and that obtained from Danish ships, have issued daily synoptic charts since December 1880.

It need scarcely be mentioned that the whole of the observations obtained from seamen are made without pay. They receive in return the publications of the *Seewarte*, and have for a number of years received other large works, which are important for them.

On the day of the inauguration of the new building of the *Seewarte* a medal was struck, which is presented to the co-operators with the *Seewarte* at sea, in three grades, together with a suitable diploma. The first grade is gold, the second silver, and the third bronze.

6. The *Deutsche Seewarte* acts as the Central Office for weather telegraphy for the empire, and especially for the storm warning system of the German coasts. Weather telegraphy.

The organisation of the whole service may be learned from the publications. The following is a list of these publications :—

1. First Yearly Report on the Organisation and Operations of the *Deutsche Seewarte*, section ix., pp. 110–27.
2. Second Do., 1879, section ix., pp. 66–74.
3. Third Do., 1880, section ix., pp. 78–92.
4. Instructions for Signal Stations of the *Deutsche Seewarte*, second edition.

It may be remarked that since 1880 the service for weather telegraphy for the German Empire has not been much extended, chiefly owing to the fact that for Prussia and the Imperial domains (Alsace Lorraine) no special offices have yet been established which could be connected with the operations in this direction.

The reports of the Central Offices of the different countries will show the condition of weather telegraphy and forecasts in the respective countries.

It is also worthy of remark that from the 1st November 1882, a limited evening service was established at the Seewarte, in the interest of storm warnings. The observations for 8h p.m. (and for England, 6h p.m.) are collected, discussed, and, if necessary, storm warnings are issued. These arrangements have been maintained, but have stopped for the summer months, and will be resumed at the commencement of the stormy season.

7. The Central Office consists of four departments, and in addition there is a course of instruction for intending teachers at navigation schools, exclusive of the administration branch. The Central Office.

The first department has charge of maritime meteorology, the second of the verification of instruments, the third of the storm signal service, and the duties pertaining to the Central Office of weather telegraphy for the German Empire.

The organisation of the Central Office at Hamburg is, so far as regards meteorology, a station of the First Order, with two, and in special cases three, sets of self-recording instruments.

For the comparison of instruments, the most tried and complete arrangements are made.

For barometers, a standard barometer with a differential cathetometer.

For thermometers, an apparatus on Fuess's principle.

For anemometers, a Combe's apparatus of 4 metres radius, and for velocity, between 1 metre and 26 to 30 metres a second, on Neumayer's principle.

From these data the arrangements for all other comparisons may be inferred.

Descriptions of the arrangements at the Central Office may be found in :—

(1.) First Yearly Report on Organisation, &c., 1875–1878, section iii. pp. 14–29.
(2.) Second Yearly Report on the Work, &c., 1879, section iii., pp. 5–7.
(3.) Third Yearly Report on the Work, 1880, &c., section iii., pp. 8–22.

In the year 1881 the *Deutsche Seewarte* was removed to the large buildings erected specially for the purposes of the Institute on the Stintfang, at Hamburg.

The arrangement of this building, as well as the structure itself, will be described in a special publication with illustrations, a reference to which can only be made here.

With regard to the arrangements of the subordinate stations of the *Seewarte*, we must refer to what has been said elsewhere in this report about the normal stations, the supplementary stations, the principal agencies, agencies, and signal stations. We must also refer to the frequently mentioned publications of the *Seewarte*.

The staff.

8. The whole system of the *Deutsche Seewarte* is under the management of a Director, who receives a salary of 525*l.*, and free apartments, provided by the State.

The First Department, for maritime meteorology, is under a head of a department, who receives an average salary of 240*l.*, with an allowance for residence.

In the First Department, three assistants are engaged, with an average salary of 135*l.*

The Second Department, for the verification for all kinds of instruments, including those necessary for meteorological purposes, is under the management of a head of a department, with an average salary of 240*l.*, and an allowance for residence.

There are two assistants in this department, with an average salary of 135*l.*

The Third Department, for meteorology and storm warnings, is under a head of a department, with an average salary of 240*l.*, with free apartments. There are five assistants engaged in this department, including an inspector of stations, with an average salary of 135*l.*

There is also a scientific assistant appointed as meteorologist to the Institute, but he is not specially attached to any of the departments. He undertakes the discussion of general scientific questions of a meteorological character, has the standing of head of a department, and receives an average salary as such.

There are also engaged in the Institute in the interest of meteorology:—

One telegraphist, with a salary of	£105
One draughtsman	100

The officials in the Administrative Department are employed for the whole Institute in all branches, and will therefore not be referred to here.

The superintendents of the principal agencies, two of which are also superintendents of stations, receive 120*l.*

The superintendents of the normal stations receive 22*l.* 5*s.* on an average.

The superintendents of agencies receive 6*l.* on an average; the superintendents of the signal stations receive 7*l.* 10*s.* a year.

The superintendents of supplementary stations (of Second Order) receive 7*l.* 10*s.*

Wherever it is practicable, the signal stations are either attached to normal stations or to the agencies, in which case the officials receive the accumulated pay.

Publications.

9°. The publications of the "*Deutsche Seewarte*" are stated in detail

in the annual reports, which have already been frequently quoted, and may be referred to here :—

I. Yearly Report, 1875–8, section xi., pp. 134–142.
II. „ 1879, „ xii., pp. 80–3.
III. „ 1880, „ xii., pp. 96–9.

Of large works, the following have appeared up to the year 1882 :—

(1.) Two volumes of "The Pilot," a guide for sailing vessels.
(2.) An Atlas of the Atlantic Ocean, which belongs to the sailing handbook, which will appear shortly.
(3.) Tables of meteorological observations, made on German and on Dutch vessels in four ten-degree squares in the N. Atlantic. Squares 146, 147, 110, 111.
(4.) The "*Monatliche Übersicht der Witterung*," 1876–82 (seven years).
(5.) The Daily Weather Reports and Charts, 1876–82 (seven years).
(6.) The Meteorological Observations on the International Scheme for 17 stations of the Second Order, 1878–80 (three years), with Hourly Observations of the Normal Stations of the *Deutsche Seewarte*.

No separate publications are issued by the stations.

Management and inspection.

10°. The management of the system, so far as this is not of a technical nature, is carried out under the superintendence of the Director by its own administrative officials.

The collection of models and instruments at the Central Office and the large library, comprising nearly 16,000 volumes, and for which a librarian is specially appointed, require special care in their management.

A special officer is appointed for the inspection of the stations ; he visits the stations and compares the instruments, &c.

The Director also visits all the stations in addition to the Inspector (say every two years), and the heads of the departments interested also inspect the stations referring to their respective departments. Generally speaking, each of the stations is inspected at least once a year, and the arrangements, books, &c. are subjected to a thorough revision.

Supplementary remarks. Historical.

11. No special remarks can be added to those already detailed above.

12. The system of the *Deutsche Seewarte*, as it at present exists, was established in January 1875, and was amalgamated with the system founded by the *Norddeutsche Seewarte* in the year 1867 for the work of maritime meteorology and meteorological observations at Hamburg.

The development of this system of the *Deutsche Seewarte* will be most plainly seen from the following publications :—

I. Yearly Report, 1875–8. Section II., pp. 4–9, Section VII., pp. 60–3, and Section IX., pp. 110–113.
II. Yearly Report, 1879, Section II., pp. 3–5.
III. Yearly Report, 1880, Section II., pp. 4–6.

The most important event in the history of the *Deutsche Seewarte* is the construction of the Central Office, the fitting up of the rooms and the installation of the instruments, which was nearly completed at the end of the year 1882, after the building had been inaugurated and occupied on the 14th September 1881.

The Grand Duchy of Baden, Central Office, Carlsruhe.

Sixteen stations of the Second Order. No stations of the First or Third Orders exist. The highest station, Höhenschwand, altitude 3,322 feet. The observations are made at 7h. a.m., 2h. and 9h. p.m. Baden does not take part (like Württemberg) in the Bavarian thunder-

storm service. The weather forecast service was introduced in May 1882, and is restricted to the warm season of the year. The forecasts were checked in June 1882 at 28 stations, and gave an average success of 82·6 %.

Publications.—A yearly report, containing—

1. Temperature, 5-day means from observations at $\frac{7+2+2+9}{4}$; monthly means from observations at 7h. a.m., 2h. and 9h. p.m., true monthly means, and yearly means.
   Extremes of temperature, for summer and winter days.
2. Atmospheric humidity. Monthly and yearly means at 7h. a.m., 2h. and 9h. p.m., for vapour tension and relative humidity.
3. Rainfall, &c., monthly and yearly amounts. Maximum in month and year. Number of days on which rain fell.
4. Amount of cloud (0 — 10) at 7h., 2h., and 9h., and mean for month and year. Number of clear and overcast days.
5. Thunderstorms; distribution according to time and place. Number of days on which thunderstorms occurred, with month and year.
6. Air-pressure, daily means for Carlsruhe and Höhenschwand, monthly means 7h. a.m., 2h. and 9h. p.m., month and year.
   Extremes of air-pressure, month and year.
7. Wind, number and force (0 — 4) of the different winds (16 points). Month and year.
8. Height of water of Lake Constance at Ueberlingen (for each day). Month, year, and extremes.
9. Summary of the weather in the different months.
10. Means and extremes of the lustra.

The Imperial Domains of Alsace-Lorraine.

After the interruption of the meteorological observations by the Franco-German war, several stations of the Second Order were established in the years 1875–7 by the Statistical Bureau of the Administration. Of the observations for the year 1877 only those of Strassburg have been published (*in extenso*). In the publications of the years 1878–81, however, the individual values as well as the monthly and yearly means of 9 or 10 stations have been published; the altitudes vary from 407 to 1,637 feet.

The management of the meteorological system is, up to the present, wanting in uniformity. In order to meet this defect and to prepare for the establishment of a central meteorological office and a station of the First Order, which shall at the same time undertake the service of weather telegraphy, Dr. Sprung, Assistant at the *Deutsche Seewarte*, was sent to Strassburg in the summer of 1882. The funds for carrying out the new organisation cannot be provided before the financial year 1884–5.

It should also be mentioned that in the year 1876 three very good working pairs of forest meteorological stations were established by the Ministry of the Imperial Domains, and in the course of the years 1873–9 about twenty Rain stations were also established by the Administration of Waterworks and Drainage. An independent monthly publication of the observations of the forest stations has existed since 1882. A meteorological service in the interest of agriculture and forestry has not yet been organised, but is to be established next year.

GERMAN EMPIRE C.—PRUSSIA.

Dr. G. Hellmann, Royal Meteorological Institute of Prussia, Berlin.

1. The Royal Prussian Meteorological Institute, was founded in the year 1847 as an independent department of the Royal Prussian Statistical Office, in which it is located and with which it is administratively connected. Definition of system.

2. The stations of the Institute embrace the non-Prussian stations in Mecklenburg, Oldenburg, Brunswick, and the small Saxon States (Saxe-Coburg, &c. &c.) which send their observations either direct or through some local authority. Number and positions of stations.

There is no actual station of the First Order, but at Schwerin two-hourly observations of air temperature and wind direction have been made since 1853 and published *in extenso* since 1880 (and formerly in abstract).

The number of stations of the Second Order amounts to 133, including the 16 forest-meteorological stations, for which the Central Office is Eberswalde. There are 24 stations of the Third Order. The four high-level stations—Schneekoppe (5,249 feet), Schneegrubenbaude (4,889 feet), Glatzer Schneeberg (3,970 feet), Brocken (3,747 feet)—are worthy of special mention.

3. The stations of the Second Order have barometers (siphon-barometers, compensated cistern barometers or cistern-siphon barometers), August's dry and wet bulb thermometers (two thermometers graduated to $\frac{1}{5}^{\circ}$), and some have also Hair-hygrometers by Höttinger and Co., of Zürich, also maximum and minimum thermometers, rain and snow gauges (the old ones with square receivers of 1 Paris sq. foot in area, the recent ones with circular receivers having an aperture of $\frac{1}{200}$ sq. metre) and wind-vanes. Organisation of stations.

The exposure of the thermometers is mostly in front of windows; metal thermometer screens on Wild's principle were erected in the year 1882 at two stations only, and at the same time ventilators were fitted to the hygrometers.

The stations of the Third Order are supplied with maximum and minimum thermometers, with check thermometers graduated to half degrees and with rain and snow gauges.

The hours of observation at most of the stations of the Second Order are 6 a.m., 2 and 10 p.m.; or else the combinations 7, 2, 9; 8, 2, 8; 8, 2, 10, are taken.

Up to the year 1879, the Instructions in force in 1847 were used, with unimportant alterations. They were then replaced by new ones, in accordance with the international regulations.

The tables of reduction in use are Jelinek's Humidity Tables (formerly those of Suhle for Réaumur degrees), and small tables on yellow cards for the reduction of the barometer.

By far the majority of the observers, who mostly belong to the educated class, reduce their own observations, so that only a few of the observations require recalculation or thorough checking. The calculations of the trustworthy observers are always subjected to a slight examination.

6. There is no special telegraphic weather service; some inland stations send their 8h. a.m. and 2h. p.m. observations by telegraph to the *Deutsche Seewarte* at Hamburg. Weather telegraphy.

7. The Central Office possesses no central observatory, but is only a central place which collects the observations of the stations, checks, dis- The Central Office.

cusses, and publishes them, verifies the instruments, inspects the stations &c. The administration (office business, registration, accounts) is carried on by the staff of the Royal Statistical Office.

The institute uses as standard barometers a cistern-siphon barometer by Fuess and a siphon barometer by T. C. Greiner, senr. The standard thermometers are from Kew and Greiner.

The staff.

8. The scientific staff is composed of a director and an assistant. See No. 7. The first receives (in the branch office), 210*l.*; and the latter 135*l.*, with an addition for apartments.

About 70 of the observers receive remuneration, those at stations of the Second Order on an average 11*l.* 5*s.*, the maximum amount being 15*l.*, those at stations of the Third Order from 2*l.* 10*s.* to 5*l.* The total amount of the remuneration paid to observers is 825*l.*

Publications.

9. The publications of the Meteorological Institute are specified in the accompanying sheet (*Preussische Statistik*).

Management and inspections.

10. From four to five weeks are taken up yearly in the tours of inspection of the stations, so that all the stations are visited once every four years.

Historical.

12. The Institute was founded in the year 1847 at the instigation of A. von Humboldt. Its directors have been A. W. Mahlmann until 1848; H. W. Dove until 1879; T. A. Arnot till 1881, and subsequently the undersigned.

For many years it has been intended to reorganise the institute completely; but owing to the difficulty in obtaining the necessary funds, which are considerable, the carrying out of the plan already prepared has not been undertaken.

GERMAN EMPIRE. D.—SAXONY.

Dr. Paul Schreiber, Chemnitz.

In returning my best thanks to you for your congratulations upon my undertaking the superintendence of the Meteorological Institute and for your contributions to our library, I have to beg that you will excuse me for not replying to the circular of the International Meteorological Committee, dated 31st December 1882. This omission has been intentional, because such important changes have taken place, and are still taking place, in my Institute, that any replies relating to 1882 would not only be worthless, but would rather do harm by the dissemination of particulars about arrangements which are now abandoned.

During the lifetime of M. Bruhns the meteorological work was pursued *con amore*, as an addition to the regular work of the Astronomical Observatory.

I have changed all this, and have now a considerable office, provided with the necessary staff (at present 9 officials) and I am endeavouring in every respect to get the Meteorological Institute taken up as a permanent establishment of the State by the time of the next session of the Diet of Saxony.

You will understand that I am desirous that no publication of our organisation should be made until after the attainment of more or less permanent arrangements.

GERMAN EMPIRE. E.—WÜRTTEMBERG.

Dr. Schoder.—Royal Central Meteorological Station of Württemberg, Stuttgart.

Number and positions of stations.

2. The Meteorological System of Württemberg consists, at present, of 24 regular stations, at which pressure, temperature, wind, cloud, rainfall, vapour tension, and humidity are observed, and of three stations which simply observe rainfall. There are also about 50 additional observers, who send in phenological notices, as well as observations of thunderstorms and hail. All these observations are collected and discussed at the Central Meteorological Station at Stuttgart (lat. 48° 47′ N., long. 36° 43′ E. of Greenwich; height above sea, 833 feet). The height above sea of the regular stations varies from 545 to 2,635 feet.

Organization of stations.

3. The regular stations are supplied with the following instruments:

(1.) Barometer: Some stations have had since 1874 cistern barometers, made by Hermann and Pfister of Berne. The cistern is generally sufficiently large to obviate the application of a correction for capacity. At the other stations siphon barometers are used.

(2.) Thermometers: Since 1872 these are all graduated in Centigrade degrees, at some stations to $\frac{1}{2}°$, at most stations to $\frac{1}{5}°$. The minimum thermometers are spirit thermometers. The thermometers are exposed in louvred screens. In addition to the dry and wet bulb thermometers, hair hygrometers are supplied to some stations, which have been lately procured from Höttinger and Co. of Zürich. The latter serve on the one hand as a check on the dry and wet bulb thermometers, and on the other occasionally replace them (*e.g.*, in winter).

(3.) Raingauges: These have mostly square receivers of one Paris foot square; for measuring, a glass tube, graduated in Paris cubic inches, is used. At the more recent stations circular gauges, like the gauges used in Switzerland, have been set up lately.

(4.) Wind vanes: These are used only in Stuttgart and a few other stations. These have a Wild's wind-pressure plate; elsewhere the wind-force is estimated.

The hours of observation are 7h. a.m., 2h., and 9h. p.m.; for rain, 7h a.m.

The reduction tables employed for the thermometer correspond with those published by Jelinek. For vapour-tension and humidity, Jelinek's tables are supplied to the observers.

Special observations.

4. Special notices about thunderstorms and hail have been received since 1874 from extra observers; since 1880 this service has been facilitated by postcards, previously printed. The method is the same as in Bavaria. The number of cards received in 1882 amounted to 787 from 52 observers.

Weather telegraphy.

6. Since the 1st April 1881, forecasts have been drawn up at the Central Office, based upon two telegrams from the *Deutsche Seewarte*, and one telegram from the Central Office in Zürich. At the same time the weather chart is printed by the hectograph process and distributed. In summer, forecasts are issued by telegraph to the country stations. A summary of the success is given in the *Monatliche Übersichten der Witterung* published by the *Deutsche Seewarte*.

The Central Office and staff.

7. and 8. The Central Office, to whose duties belong the taking of daily observations of the weather, has the undersigned as Director, and as meteorological assistant, the engineer L. Meyer, of Stuttgart. The latter is entrusted with the special duty of drawing up the forecasts and of drawing the Weather Charts. In addition to the above-mentioned instruments, the Central Office possesses a registering aneroid-barometer

by Goldschmid, of Zürich, a registering thermometer and wind-gauges by Hermann and Pfister of Berne and by Goldschmid.

	£	s.
The Director draws a salary of -	90	
The assistant „ „ -	91	5

and the observers receive remunerations of between 3*l.* and 10*l.* The special observers received 20*l.* altogether in 1882.

Publications.

9. The Central Office publishes:

(1.) The Daily Weather Reports of Stuttgart in the newspapers, "*Staatsanzeiger für Württemberg*," and "*Schwäbischer Merkur*."

(2.) The Stuttgart observations in the medical *Correspondenzblatt*.

(3.) The monthly results of the observations of all stations in the "*Staatsanzeiger für Württemberg*."

(4.) A weather report containing the results of observations of the stations in the Württemberg Year-books for Statistics and Agriculture.

Of the publications (2) to (4) are printed separately and sent abroad.

Management and inspections.

10. The financial management is undertaken by the Statistical and Topographical Office, to which the meteorological stations are subordinate, and of which the Director of the Central Meteorological Office is a permanent officer. The Director inspects the stations, the more important stations being visited every year.

Historical.

12. Since 1825 there has been in existence an Association of volunteer observers; these use their own instruments and observe on a uniform plan laid down by Professor Schübler and M. von Plieninger. The results were published in the "*Correspondenzblatt*" of the Agricultural Society of Württemberg. In 1844 the Association of Observers joined the newly founded Society for Natural Science; the publication of the results was made in the annual reports of the same until 1854. In 1855 the development of the meteorological statistics of the country was fixed as one of the duties of the Statistical and Topographical Office, and a sum of money was provided for the purchase of instruments, for remuneration, &c. It became possible thereby to establish more stations at points not hitherto represented, to supply the stations with uniform and compared instruments, and in the event of an observer leaving, it was easier, by offering remuneration, to find a successor, and to secure the continuance of the station.

Weather Reports have been issued since 1855 by the above-mentioned office, and since 1864 in special publications by Plieninger, who in 1867 published a resumé of 40 years results, viz., 1825–64.

In the year 1865 the present Director undertook the management of the stations and also the publication of the yearly reports in the Württemberg Year-books. In 1872 the centigrade thermometer was adopted and the graduation of the barometer in millimetres. From this cause and other minor changes which have taken place since the communication of the monthly results of a number of stations to the Royal Statistical Bureau of Prussia, drawn up by Plieninger, two supplements were issued ,to the Instructions in 1873. A third supplement became necessary, in order to conform to the decisions of the Meteorological Congress at Vienna.

Until 1864 it had been the practice of the observers to send in their observations for each year at the beginning of the next, which caused many difficulties in the checking. From 1865, therefore, the registers were collected monthly, by which means it became possible to publish a monthly summary of the weather in the "Staatsanzeiger."

In 1874, in accordance with the decisions of the Vienna Congress, the Central Station at Stuttgart was established, the director of which, Dr.

Schoder, undertook the daily weather observations. In addition to the 24 regular meteorological stations, which were partially provided with better instruments, a large number of special observers were appointed in 1874, who have to send reports to the Central Station respecting hail, thunderstorms, and the animal and vegetable kingdom. Since 1878 some rainfall stations have been added. From 1874 the Central Station has received daily telegrams, originally sent from Berlin, and from the beginning of 1876 by the *Seewarte* at Hamburg. These, with the addition of reports from Friederichshafen and Stuttgart, were communicated to the "Staatsanzeiger." Württemberg is represented by Friedrichshafen, in the system of stations of the *Deutsche Seewarte*, and by Stuttgart and Friedrichshafen in the system of simultaneous observations originated at Washington by General Myer. The same two stations appear also in the German publications:—*Meteorologische Beobachtungen in Deutschland.* In the summer of 1880, thunderstorm cards were first introduced on the Bavarian plan, according to which the regular and special observers communicate the occurrence of thunderstorms on a form printed on a postcard. On the 1st April 1881, the central station at Stuttgart commenced the issue of weather forecasts, and on the 1st June following distributed the same by telegraph.

GREAT BRITAIN AND IRELAND.

A.—*R. H. Scott, Meteorological Office, London.*

1°. The Meteorological Office is managed by a Council, nominated by the President and Council of the Royal Society, at the request of the Government. Definition of system

The meetings of the Meteorological Council are held once a fortnight, or oftener when necessary.

The operations of the Office comprise the three following divisions:—

I. *Ocean Meteorology.*

II. *Weather Telegraphy and Signals.*

III. *Land Meteorology of the British Islands.*

2°. There are seven stations of the First Order, under the control of the Central Office (see also reply to 11°):— Number and position of stations.

Valencia,	lat.	51° 55′ N.,	long.	10° 18′ W.,	altitude	23	feet.
Armagh,	„	54° 21′ N.,	„	6° 39′ W.,	„	207	„
Glasgow,	„	55° 53′ N.,	„	4° 18′ W.,	„	184	„
Aberdeen,	„	57° 10′ N.,	„	2° 6′ W.,	„	88	„
Falmouth,	„	50° 9′ N.,	„	5° 4′ W.,	„	211	„
Stonyhurst,	„	53° 51′ N.,	„	2° 28′ W.,	„	361	„
Kew,	„	51° 28′ N.,	„	0° 19′ W.	„	34	„

Self-recording anemometers have also been erected at the following stations:—

Alnwick Castle,	lat.	55° 25′ N.,	long.	1° 43 ′W.
Holyhead,	„	53° 22′ N.,	„	4° 37′ W.
Sandwick,	„	59° 2′ N.,	„	3° 18′ W
Seaham,	„	54° 50′ N.,	„	1° 19′ W
Scilly,	„	49° 56′ N.,	„	6° 18′ W.
Yarmouth	„	52° 37′ N.,	„	1° 43′ E.

There are 43 stations of the Second Order (including some stations of the Meteorological Society, which supply observations to the Central Office), and 18 stations of the Third Order, in addition to 30 telegraphic reporting stations and some rainfall stations.

Organization of stations.

3°. As far as possible the stations of the First Order have been established at existing institutions, in which case a payment is made annually to each institution for carrying on the work. At Valencia the observatory is under the direct management of the Office. The instruments have all been supplied by the Central Office, and include photographic barograph and thermograph, Robinson's anemograph, Beckley's self-recording rain gauge, and other meteorological instruments in use at a first-class observatory.

The caretakers at the anemograph stations receive 10*l.* or 15*l.* a year, except at Alnwick Castle, where the instrument belongs to the Duke of Northumberland, who supplies the records to the office free.

The observers at stations of the Second Order are all volunteers, and observe regularly at 9 a.m. and 9 p.m. The instruments are the property of the observers, and are all duly verified.

The observers at stations of the Third Order are also volunteers, and observe wind, temperature, and sometimes rainfall, once a day. The tables of reduction used at all stations are the "Instructions in the use of Meteorological Instruments," by R. H. Scott, M.A., F.R.S.

With regard to the checking of the returns from the self-recording observatories. The measurements are subjected to a careful examination in order to ensure as far as possible their accuracy, and the regulations which have been adopted to secure this end will be found fully detailed in the Report of the Office for 1868. They comprise rules for the guidance of observers, as well as of the assistants charged with the examination of the work at the Office. The attention of the observers is always drawn to such errors as may be detected, and to any failures in the continuity of the curves arising from failure of the light, stoppage of the clock, defective photography, faulty action of the wet-bulb thermometer, &c.; a report containing the results of the examination of each observatory being also submitted to the Council each month and printed in their minutes.

With regard to the stations at which *direct* observations are made.

All the returns are carefully examined and compared before being copied for the printer. The reduction of all the barometer readings to 32° Fahr. at mean sea level is checked, and the corrected readings are then compared with the isobars on the Daily Weather Charts and readings at neighbouring stations, allowance being made for any difference in time and the corresponding change in barometric pressure.

The correction of the readings of the dry-bulb and damp-bulb thermometers is checked, and the maxima and minima temperatures are compared with the dry-bulb thermometer readings over the same periods to ensure that they are the extreme temperatures registered.

The computed values of the vapour tension and the relative humidity are examined from the tables. The cloud amount is compared with the weather at the time of observation, and finally, the sums and means are all re-calculated.

If any readings are doubtful, reference is made through the observer to the original observation book. If no fresh light is thrown on the question by this means, and if on reconsideration the reading still appears to be wrong, it is rejected, and the probable reading is inserted in its place, but printed in different type as an interpolation. These probable readings are used in obtaining the monthly means. Similarly, if from any cause a set of readings has been omitted, the gap is filled by an interpolation, and the probable values are printed in different type.

Special observations.

4°. Special observations of hail, thunderstorms, and periodical phenomena are not regularly made for this Office, except casually by telegraphic

reporters, but phenological observations are regularly made and published under the auspices of the Meteorological Society.

5°. The method which has been followed by the Office, since its first establishment in 1854 up to the present date, in the collection of information on Ocean Meteorology, has been to supply officers of the mercantile marine with a complete outfit of verified instruments, on the condition of their returning, at the completion of the voyage, the instruments, and the log of observations made with them, to the Office, or to one of its Agents. Marine meteorology.

Every instrument supplied has been originally verified at Kew observatory, and on the completion of the voyage it is compared with a standard instrument either at the Office or by one of its agents. Under ordinary circumstances it is not requisite to send the instruments to Kew for re-verification after every voyage, as the changes in their errors are generally slight.

The regular outfit of a ship consists of:—

1 Barometer (Kew pattern).
6 Thermometers, with a thermometer screen.
4 Hygrometers.

The first record of observations is made in a rough book supplied for the purpose, which is retained by the captain, who copies the observations into a meteorological log kept for the Office.

In order to facilitate communications between the Office and the observers, Agencies are established at some of the principal ports, and instruments are supplied directly from such agencies to the ships.

As regards the Royal Navy, Her Majesty's Ships have been supplied by the Office, since its foundation in 1854, with the meteorological instruments used in the service. The records of observations made by naval officers are in due course deposited at the Admiralty, where they are available for use. It is optional with the observers to keep for the Office a meteorological log in addition to the regular record of observations required by the rules of the service.

Meteorological logs received at the Office, whether from Her Majesty's ships or from the Mercantile Marine, are tested according to a definite form (the "test sheet," which has been published in the Report of the Maritime Conference of London, 1874, p. 35), and the observations are classified according to their quality.

As soon as this first testing has been effected, a letter is written to the captain, and if any questions arise to which he can probably give an answer, he is requested to do so while the incidents are fresh in his memory. The replies are noted in the log for future reference.

In addition to the meteorological logs received from the Navy, a full set of observations is made at one epoch on each day by all of Her Majesty's ships, in whatever part of the world they may be stationed. These are entered on monthly forms, and forwarded to the Office as soon as possible after the end of each month. Officers of the Mercantile Marine who keeping meteorological logs, are also invited to co-operate in keeping the synchronous observations, and in numerous instances the observations are well and regularly made. By these means the Council are in early possession of valuable observations which cover, to some extent, the navigable seas of the Globe.

A special collection is being made of weather observations in the North Atlantic for the 13 months beginning 1st August 1882, and ending 31st August 1883.

The following figures will give an idea of the activity of the marine branch of the Office. The figures refer to the supply of instruments

for keeping the regular meteorological log, exclusive of synchronous observations:

Instruments supplied, &c. to the Royal Navy.

—	Barometers.	Aneroids.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1883, afloat - -	176	378	1,073	151	133	100	128

Instruments supplied, &c. to Mercantile Marine.

—	Barometers.	Thermometers.				Hydrometers.
		Ordinary.	Max.	Min.	Screens.	
April 1st, 1883, afloat - -	140	764	—	—	145	493

The number of regular meteorological logs returned from ships in 1882 amounted to 155, and embraced 765 months of actual observations.

It needs scarcely be said that all such observers are volunteers; their only recompense is a copy of the publications bearing upon ocean meteorology.

Weather telegraphy.

6°. *Telegraphic Weather Service.*—The Office receives, when the telegraphic communications are perfect, 53 reports every morning, 13 every afternoon (except on Sundays), and 19 each evening.

The foreign reporting stations, 23 in number, extend along the entire western coast of the Continent, from Bodö in lat. 67° N. to Corunna in lat. 43° N., and include four stations on the coast of the Baltic, and one in the Mediterranean. The names of these stations are published in the annual reports of the Office.

At the British stations the morning observations are taken at 8 a.m. Greenwich time, and most of the telegrams arrive between 9 and 10 a.m.

The information is entered on a working chart, which shows for each station at 8 a.m. the barometrical and thermometrical readings, with their respective alterations during the preceding 24 hours, the direction and force of the wind, and the state of the weather, together with any changes of importance which may have been noticed in the course of the preceding day. From this chart, which is preserved in the Office, other charts referred to below are then drawn for publication in the newspapers.

Telegraphic *resumés* of the weather, or the actual telegrams, are sent to Copenhagen, Christiania, Hamburg, Jersey, and Paris, and, in the event of stormy weather, to Utrecht also.

A constant watch is kept during the day, and whenever on the receipt of the regular, or of special, telegrams the condition of the weather appears to be threatening, cautionary messages are at once issued to such parts of the coast as are thought to be menaced by a gale.

Forecasts of the weather, for one day in advance, are drawn up for 11 districts in the British Islands, and issued to subscribers, to certain clubs, and to many of the London and Provincial newspapers.

The forecasts are issued at 11h. a.m. and 8.30 p.m., for publication in the morning newspapers. The average success attained is 76 per cent.

For some years special forecasts have been issued during the hay season, further particulars of which will be found in the Annual Report.

Daily weather charts are lithographed and largely distributed, both to subscribers, and also free for exhibition on the coast and elsewhere.

This lithographed report contains (1) a map of North-western Europe, showing for 8 a.m. on the date of publication the distribution of pressure, the prevalent winds, and the sea disturbance; (2) a similar map showing the distribution of temperature, the weather at each station, and the distribution of rainfall during the past 24 hours; (3) remarks on the principal features exhibited by the reports for the day, with the forecasts drawn up for each district at 11 a.m. relating to the weather likely to be experienced during the 24 hours ending at noon on the day after that of publication; (4) the whole of the reports on the above charts, remarks, and forecasts have been drawn, together with the 2 p.m. and 6 p.m. reports of the previous day.

There is also a Sunday service for the reception of telegrams, and for the issue of storm warnings to the coasts and forecasts for the Monday morning papers.

The Office also issues a Weekly Weather Report, giving the average and extreme temperatures and the rainfall values and the total amount of bright sunshine in each week, for ten districts in Great Britain and Ireland, together with the difference between these and respective mean values for the corresponding weeks in previous years.

The telegraphic reporters are telegraph clerks, schoolmasters, signalmen, and the like, and they receive a remuneration varying from 13*l.* to 20*l.* a year.

A more complete description of the methods followed in this department is published in the Annual Reports.

7°. The Central Office, as stated in § 1°, is divided into three general heads; there is also an administrative department, which attends to correspondence, accounts, library, issue of publications, and all routine matters. The central observatory of the Office at Kew is only distant a few miles, so that only few observations are taken at the Office, which is not sufficiently open for the purpose. The Central Office.

The subordinate stations and supply of instruments have been referred to under other heads.

8°. The staff of the Central Office is composed as follows:— The staff.

I.—*Ocean Meteorology.*

	£
Marine Superintendent - - -	400
Assistant ditto - - -	250
5 Clerks and 2 Boys - - -	483 average for last five years.

During the collection and discussion of the synchronous observations for the North Atlantic, for a year ending 31st August 1883, a special temporary staff has been engaged at a weekly cost of (say) 6*l.* 10*s.* 0*d.*

II.—*Weather Telegraphy and Signals.*

1 Senior Clerk, 300*l.* and allowance for extra attendance.
6 Clerks - - }
2 Boys - - } 1,090*l.* average for last five years.
1 Messenger - }

The office hours for this branch are 9 *per diem*, with late evening and Sunday attendance. In other branches of the Office the hours are 8 daily.

III.—*Land Meteorology of the British Islands.*

	£
1 Senior Clerk - - - -	267
6 Clerks - - - - }	1,147
1 Engraver - - - - } average for last	
5 Boys - - - - } five years.	

IV.—*Administration.*

	£
Secretary - - - - -	800
Chief Clerk - - - - -	333
2 Clerks, 1 Boy, Office Keeper, and Messenger - - - - } average for last five years.	385

This amount is exclusive of the sum paid in fees to the Superintending Council, viz., 1,000*l.* a year.

Departments II., III., and IV. are under the general management of the Secretary.

The payments to the observers at stations have been referred to under other heads.

The stations of the First Order, the seven observatories, receive a regular annual allowance of about 250*l.*; at Valencia the sum is higher. The observers at the stations of the Second Order are all volunteers. The telegraphic reporters are paid as already explained.

Publications. 9°. The list of published books, &c. is printed on the cover of each publication of the Office.

In addition, lithographed Daily Weather Charts and printed Weekly Weather Reports are issued to the number of about 500, more than half of which are distributed free.

The Hourly Readings of Pressure, Temperature (Dry and Wet thermometers), Wind (Direction and Velocity), and Rain at all the seven observatories are printed and distributed with other ordinary publications.

No independent publications are issued by the stations, with the exception of the results of the observations by some of the observatories.

Management and inspections. 10°. The self-recording observatories and the anemographic stations, as well as the telegraphic reporting stations, are regularly visited each year by the inspectors of the Office. The extra stations are inspected as opportunity offers. Of the stations of the Second Order, some belong to the Meteorological Society (of London); these are visited by an inspector appointed by the Society, an allowance being made by the Office towards the cost of the inspection. The remaining Stations of the Second Order, which are in immediate connexion with the Meteorological Office, are visited at least once in every two years by the inspectors of the Office. The Superintendent of the Kew Observatory is especially employed to inspect and report on the self-registering apparatus, and on the photographic processes at the observatories. Extracts from the reports of the inspectors will be found in the Annual Reports.

Two of the inspectors, viz., for England and Scotland, each receive a salary of 150*l.* a year, in addition to travelling expenses.

Supplementary remarks.

11°. There are various establishments and systems in the British Isles not connected with the Central Office, the chief of which are the Observatory of Greenwich, the Radcliffe Observatory, Oxford, and the Bidston Observatory, all of which possess self-recording instruments; and the Meteorological Society, for which a special reply is annexed. The British rainfall system counts as many as 2,000 observers.

The Scottish Meteorological Society also possesses an extensive organisation, details of which are given in the "Journal" published by that society.

In addition to the subjects which fall under the heads above mentioned, the Council give attention to special researches and experiments such as those referring to London fogs, balloon observations, rainfall, hygrometry, atmospheric electricity, &c. Such investigations are usually entrusted to gentlemen outside the Office, who have special knowledge of the subjects in question.

Historical.

12°. The establishment of the Meteorological Office may be said to be the outcome of the Brussels Conference held in 1853, for, immediately after that meeting, the Royal Society urged upon the Government the importance of a uniform system of meteorological observations at sea. In 1854 the President of the Board of Trade resolved to establish a Meteorological Department in connexion with the Marine Department of that office, and appointed Admiral (then Captain FitzRoy) as its chief. Admiral FitzRoy began work on a very comprehensive scale, and worked vigorously in the branch of ocean meteorology until 1860, when his attention was turned to weather telegraphy. To him is mainly due the credit of establishing the now general system of storm warning signals. He died in 1865, and in 1867 the Government placed the management of the Office under a Committee of the Royal Society with a grant of 10,000*l.* a year and free printing. This Committee continued the work of Admiral FitzRoy in branches I. and II., and added No. III. (Land Meteorology). The chairman of this Committee was Sir E. Sabine. In 1877 the Office was reconstituted, and placed under the management of the Meteorological Council, who are nominated by the Royal Society and appointed by the Government, and dispose of an annual grant at present amounting to 15,300*l.* The first chairman of the Council was Professor H. J. S. Smith, F.R.S., in whose recent death the Office has sustained a very serious loss. The Royal Society have now (March 1883) nominated Lieutenant-General R. Strachey, C.S.I., F.R.S., as chairman of the Council.

B.—*Meteorological Society, London.*

Definition of system.

1. The stations in connexion with the Meteorological Society were organised with the view of furnishing trustworthy data for determining the climate of the British Isles.

Number and position of stations

2. The number of stations in 1882 were 25 Second Order and 64 climatological (Third Order).

Organization of stations.

3. At the Second Order Stations the hours of observation are 9h. a.m. and 9h. p.m. local time. The maximum and minimum thermometers are read and set at 9h. p.m., and the readings entered to the day on which they are read.

At the Climatological Stations the observations are made once each day, viz., at 9h. a.m. The reading of the maximum thermometer is entered to the previous day, but the reading of the minimum is entered to the day on which it is read.

The instructions issued to the observers are those contained in "'Hints to Meteorological Observers, with Instructions for taking "'Observations and Tables for their Reduction.' Prepared under the "direction of the Council of the Meteorological Society by William "Marriott, Assistant Secretary," London, 1881.

All the observations are scrupulously examined, the readings at each station are first carefully compared with those at the adjacent stations, and then the readings on the return are examined *inter se*. The corrections, calculations, and reductions are also checked, all the work being gone over by two separate computers.

ecial observa-ns.

4. Special observations of phenological phenomena are made at 47 stations, and the results discussed by the Rev. T. A. Preston in an annual report, which is published in the "Quarterly Journal." The list of plants, insects, birds, &c., to be observed is given in the "Instructions for the Observation of Phenological Phenomena," 2nd edition, London, 1883.

rine observa-ns.

5. No observations are made at sea for the Society, but papers based on such observations are occasionally read at the meetings and printed in the "Quarterly Journal."

eather egraphy.

6. There is no telegraphic weather service in connexion with the Society.

e Central ice.

7. The Society's Office is at No. 30, Great George Street, Westminster. The observers are nearly all volunteers, and provide their own instruments.

e staff.

8. The staff consists of the assistant-secretary, with a salary of 155*l*., and three computers, whose pay in 1882 amounted to 101*l*. 8*s*.

All the observers give their services gratuitously except one, who receives a small payment.

blications.

9. The Society issues two publications, viz.:—

1. "The Quarterly Journal," which contains the papers read at the meetings, abstracts of the discussions, the Proceedings of the Society, and other information; and
2. "The Meteorological Record," which contains the monthly results of observations made at the stations of the Meteorological Society, with remarks on the weather for each quarter.

anagement d inspections.

10. The Council exercise a general supervision over the stations, which are inspected by the assistant-secretary every two years, those in the north being visited one year and those in the south the next. The reports on the inspection are published in the "Quarterly Journal."

pplementary marks.

11. Copies of the daily observations from 14 stations are supplied to the Meteorological Office for publication in full in the "Meteorological Observations at Stations of the Second Order."

istorical.

12. In 1874 the Society commenced the organisation of a series of Second Order Stations, at which the observations are made on a uniform plan, so that the results might be strictly comparable with each other.

In addition to these, another class of stations was started on January 1, 1880, viz., the climatological, at which observations of the dry bulb, wet bulb, maximum and minimum thermometers, amount of cloud, rainfall, and weather, are made once daily at 9 a.m.

C.—*W. H. M. Christie, Astronomer Royal, Royal Observatory, Greenwich.*

In the Meteorological Section of the Magnetical and Meteorological Department of the Royal Observatory, continuous photographic record is maintained of the barometer, of the dry bulb and wet bulb thermo-

meters, and of Thomson's electrometer; also continuous automatic record of the direction and pressure of the wind, and rainfall (by Osler's anemometer), of the horizontal movement of the air (by Robinson's anemometer), of the duration of sunshine (by Campbell's instrument), and of the amount of ozone.

Eye observations of the standard barometer and of the standard dry bulb and wet bulb thermometers are taken daily at 9 a.m., noon, 3 p.m., and 9 p.m.; also observations of self-registering maximum and minimum thermometers, and of thermometers for solar and terrestrial radiation. Earth thermometers (four, having bulbs respectively 24, 12, 6, and 3 French feet below the surface) are read daily at noon. Rain gauges on the ground and at different elevations up to 51 feet are read daily.

A general record of atmospheric changes is kept, and numerical estimations of the amount of cloud are made at 9 a.m., noon, 3 p.m., and 9 p.m.

Results deduced from these records and observation are published annually (with those deduced from the magnetic observations) in the Magnetical and Meteorological Section of the Greenwich Observations.

Regular observations of the principal magnetical and meteorological elements were commenced at the Royal Observatory in the year 1840; the photographic process was introduced in the year 1848.

The Magnetic and Meteorological Department of the Royal Observatory is under the direction of the Astronomer Royal. The staff of the department consists of a superintendent, with salary ranging from 320*l.* to 450*l.*, and one assistant, with salary ranging from 180*l.* to 250*l.* An annual sum of 230*l.* is allowed for the employment of computers.

D.—*G. M. Whipple, Kew Observatory, Richmond, Surrey.*

In reply to your circular of the 31st December 1882, I have the honour to inform you that this establishment has had no independent meteorological organisation since 1867, at which time it became one of the first-class stations of the Meteorological Committee, and remains so at the present date.

This does not, however, apply to the magnetical branch of the Observatory work, which since 1871 has been conducted under the auspices of a committee of the Royal Society.

GREAT BRITAIN AND IRELAND. COLONIES. A.—CANADA

C. Carpmael, Esq., Metcorological Office, Toronto.

I have much pleasure in forwarding the following statement in reply to your circular dated December 31st, 1882 :—

1. The meteorological system of Canada comprises— Definition of system.
   - (i.) A central office entrusted by the Government with the management, collection, and publication of the meteorological observations of the country and the issue of weather forecasts and storm warnings.
   - (ii.) A number of observing, and
   - (iii.) Publishing stations.

2. Of the observing stations there is but one that answers to the definition of a Station of the First Order contained in Appendix I. to the Protocol of the Ninth Meeting of the Vienna Conference, but there are ten others at which observations more or less are taken at regular Number and position of stations.

intervals, six, ten, or twelve times per day as under. (See List of Stations.)

There are 82 Stations of the Second Order; and there are 91 Stations of the Third Order.

This does not include stations which merely send in storm reports or short statements of weather, used in ascertaining how far the weather predictions are fulfilled.

The following is the list of stations:—

Meteorological Service. Dominion of Canada.

Stations of the First Order, or partially so.

Stations.	Lat.	Long.	Remarks, Hours of Observation, &c.
	° ′	° ′	
Toronto (Central Office)	N43 39	W19 23	Self-recording magnetographs, thermograph, barograph, anemograph, and sunshine recorder. Eye observations each second hour, from 6 a.m. to midnight inclusive. Three daily observations for weather telegraphy. Daily observation of actinometer, sunshine recorder. Monthly determination of magnetic dip. Intensity and declination.
Sydney, N.S.	46 8	60 10	Full observations each second hour. Self-recording anemograph. Sunshine recorder.
Halifax, N.S.	44 39	63 36	Full observations each third hour. Self recording anemograph. Three daily observations for weather telegraphy.
St. John, N.B.	45 17	66 3	Observations for temperature every second hour. Other observations six times daily. Self-recording anemograph.
Fredericton, N.B.	45 57	66 38	Full observations at each third hour. Self-recording anemograph. Sunshine recorder.
Montreal	45 30	73 35	Full observations at every fourth hour. Self-recording anemograph. Sunshine recorder.
Quebec	46 48	71 12	Observations for temperature every second hour. Extremes. Rain, &c. Self-recording anemograph.
Kingston	44 14	76 29	Observations for temperature every second hour. Extremes. Rain. &c.
Woodstock	43 8	80 47	Observations for temperature at each third hour. Other observations three times daily. Self-recording anemograph. Sunshine recorder.
Winnepeg (Man.)	9 55	97 7	Full observations at each third hour. Self-recording anemograph. Sunshine recorder.
Westminster, B.C.	49 12	122 53	Full observations at each third hour.

Stations of the Second Order.

(*) Have not been supplied with barometer.
(*a*) Take an extra observation for international bulletin.

Station.	Lat.	Long.	Unless otherwise stated, Observations are made at 7 a.m., 2 and 9 p.m., Local Time.
	° ′	° ′	
Newfoundland:			
St. John's	N47 34	W52 42	8.37 a.m., 4.37. p.m., 8.37 p.m.
St. Pierre (*a*)	46 47	56 12	10 a.m., 4 p.m.
Notre Dame Bay	50	57	8 a.m., 2 and 8 p.m.
Chanvel	47 34	59 7	8 a.m., 2 and 9 p.m.
Nova Scotia:			
Baddeck	46 6	60 49	8 a.m., 2 and 9 p.m.
Picton	45 42	62 41	——
Truro	45 22	63 18	——
Windsor (*a*)	44 59	64 6	Self-recording anemograph, and self-recording rain gauge.
Yarmouth	43 50	66 2	6.50 a.m., 2.50 and 10.50, Toronto time.
New Glasgow (*)	45 41	66 39	——
New Brunswick:			
Bird Rocks (Magdalen Islands).	47 51	61 8	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Bathurst (*a*)	47 39	65 42	7.45 a.m., 2 and 7 p.m.
Chatham	47 3	65 29	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Dalhousie (*a*)	48 4	66 22	——
Point Le Preaux (*)	45 4	66 27	——
St. Andrews	45 5	67 4	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.

STATIONS of the SECOND ORDER.—*continued.*

Station.	Lat.		Long.		Unless otherwise statad, Observations are made at 7 a.m., 2, and 9 p.m., Local Time.
PRINCE EDWARD'S ISLAND:	°	′	°	′	
Charlottetown	46	14	63	10	6.50 a.m., 2.50 and 10.50 p.m., Toronto time. Self-recording anemograph.
Kilmahumaig (*)	46	48	64	2	10 a.m., 4 and 10 p.m.
QUEBEC:					
Anticosti	49	24	63	36	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Chicontimi	48	25	71	5	——
Cranbourne	46	22	70	37	——
Danville (*)	45	47	72	1	——
Father Point	48	31	68	28	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Huntingdon	45	5	74	10	——
Quebec Obsy	46	48	71	13	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Richmond (*)	45	40	72	88	——
HUDSON'S BAY:					
Port Albany	52	12	82	5	8 a.m., 2 and 7 p.m.
Moose Fort (*a*)	51	16	82	56	——
York Factory (*a*)	57	0	92	26	——
Marten's Falls	51	30	86	30	7 a.m., 2 and 7 p.m.
ONTARIO:					
Birnam	43	2	81	55	——
Bancroft	45	1	77	50	——
Barrie	44	53	79	40	7 a.m., 1 and 9 p.m. Sunshine recorder.
Beatrice (*)	45	8	79	20	——
Brampton (*)	43	41	79	46	——
Conestogo	43	33	80	31	——
Cornwall (*a*)	45	1	74	43	7 a.m., 1 and 9 p.m. (Sunshine recorder.)
Durham (*)	44	10	80	50	——
Desoronto	44	11	77	4	——
Egremont (*)	44	0	80	57	——
Fitzroy Harbour	45	30	76	14	——
Goderich	43	45	81	43	7 a.m., 1 and 9 p.m.
Grafton (*a*)	43	12	81	21	——
Gravenhurst (*)	44	54	79	20	——
Guelph	43	33	80	16	——
Hamilton (*a*)	43	16	79	53	7 a.m., 1 and 9 p.m.
Huntsville	45	30	79	8	——
Kincardine	44	11	81	37	7 a.m., 11 p.m.
Kingston	44	14	76	29	6.50 a.m., 2.50 and 10.50 p.m., Toronto time. Sunshine recorder.
Lindsay	44	20	78	45	Sunshine recorder.
Mount Forest (*a*)	43	58	80	44	——
Mamainse	47	30	84	50	——
Ottawa	45	26	75	41	7 a.m., 1 and 9 p.m.
Parry Sound	45	19	80	00	6.50 a.m., 2.50 and 10.50 p.m., Toronto time. Self-recording anemograph.
Pembroke	45	50	77	7	7 a.m., 1 and 9 p.m. Sunshine recorder.
Peterborough (*a*)	44	17	78	18	Do.
Penetanguishew	44	45	79	56	——
Point Clark (*)	44	5	81	44	——
Port Dover	42	47	80	13	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Port Stanley	42	40	81	13	Do. Self-recording anemograph.
Prince Arthur's Landing	48	27	89	12	Do. do.
Rockliffe	46	12	77	55	Do.
Saugeen	44	30	81	21	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Simcoe	42	50	80	21	7 a.m., 1 and 9 p.m.
Stratford (*a*)	43	23	81	0	Do. Sunshine recorder.
Strathroy	42	56	81	42	——
Welland (*)	42	59	79	17	7 a.m., 1 and 9 p.m.
Windsor	42	19	83	2	Do. Sunshine recorder.
MANITOBA AND NORTH-WEST TERRITORY:					
Winnipeg	49	53	97	7	——
Poplar Heights	50	4	97	47	7 a.m., 1 and 9 p.m.
Stoney Mountain	50	5	97	12	——
Rapid City	50	7	100	0	——
Oak Lake	49	45	100	35	8 a.m., 1 and 9 p.m.
St. Andrew	50	5	97	0	——
Battleford	52	41	108	30	1 p.m., 9 p.m.
Fort Calgary	50	55	113	45	8 a.m., 2 and 9 p.m.
Edmonton	53	14	113	38	0.23 p.m., 8.23 p.m.
Humbolt	52	12	105	10	1.7 p.m., 9.7 p.m.
Munnedosa	50	14	99	47	5.27 a.m., 1.27 and 9.27 p.m.
Fort Dunvegan (*)	56	?	118	20	——
B.C. Spence's Bridge (*)	50	25	121	30	7 a.m., 1 and 9 p.m.
B.C. Grand Prairie (*)	50	28	119	48	7 a.m., 1 and 8 p.m.

Stations of the Third Order.

(*b.*) Supplied with Maximum and Minimum Thermometers.

Station.	Lat.	Long.	Remarks.
	° ′	° ′	
Cow Bay	N 46 8	W 59 52	
Little Glace Bay (*a*)	46 12	59 58	
White Point	46 52	60 22	
Broad Cove (*b*)	46 17	61 12	
Port Hastings	45 39	61 24	
Antigonistic (*b*)	45 38	61 59	
Dorchester	45 55	64 32	
Moncton (*b*)	46 6	64 49	
Hampton	45 33	65 50	
St. François (*b*)	46 13	70 48	
Barnston	45 6	71 28	
Brome (*b*)	45 12	72 34	
L'Original (*b*)	45 38	74 42	
Lodi	45 12	75 2	
Lunenberg	45 4	75 2	
Edwardsburg	44 50	75 25	
Metcalfe	45 16	75 28	
Augusta	44 47	75 42	
Merrickville	44 57	75 52	
Addison	44 41	75 54	
Renfrew	45 26	76 39	
Northcote (*b*)	45 30	76 46	
Newburgh	44 19	76 53	
Clontarf	44 23	77 9	
Norwood (*b*)	44 22	77 59	
Lakefield (*b*)	44 25	78 15	
Port Hope	43 56	78 20	
Ennismore	44 23	78 27	
Mattawa (*b*)	46 15	78 41	
Hampton	43 57	78 47	
Oshawa (*b*)	43 33	78 52	
Kirkfield	44 32	78 57	
Brechin (*b*)	44 30	79 10	
Bracebridge	45 1	79 17	
St. Catherine's	43 10	79 17	Sunshine Recorder.
Georgina	44 19	79 18	
Orillia	44 34	79 24	
Newmarket	44 2	79 29	
Port Credit	43 34	79 36	
North Glanford	43 11	79 57	
Georgetown	43 39	79 58	
Brantford (*b*)	43 10	80 21	
Fergus	43 42	80 24	
Otterville	42 57	80 37	
Owen Sound (*b*)	44 54	80 55	
Presque Isle	44 42	80 55	Anemometer.
Ingersoll	43 2	80 57	
Listowell	43 44	80 58	
St. Thomas	42 47	81 13	
Brussels	43 44	81 14	
Wilton Grove	42 56	81 17	
Egmondville	43 31	81 25	
Delaware	42 53	81 26	
Seaforth	43 32	81 26	
Lucan	43 10	81 27	
Hensall	43 25	81 32	
Ailsa Craig	43 8	81 36	
Zurich (*b*)	43 24	81 38	
Colborne	43 45	81 38	
Glencoe	42 45	81 43	
Goderich and House	43 45	81 43	Anemometer.
Thamesville	42 32	82 1	
Florence	42 39	82 1	
Sarnia	42 59	82 24	
Stoney Point	42 19	82 33	
Cottam	42 7	82 45	
Tecumseh	42 19	82 54	
Maidstone	42 13	82 54	
Amherstburg	42 6	83 7	
Nicola Lake	50 16	120 43	
Cache Creek	50 49	121 27	
Hope	49 23	121 28	
Douglas Lake	50 57	121 30	
Lillooet (*b*)	50 42	122 2	
Soda Creek (*b*)	52 20	122 19	
Langley	49 11	122 32	

STATIONS of the THIRD ORDER.—*continued.*

Station.	Lat.	Long.	Remarks.
	° ′	° ′	
Clinton - - -	51 6	122 48	——
Ladwen Landing (*b*) -	49 6	123 4	——
Heath Point } Anticosti {	49 5	61 43	Tri-daily observations of temperature, weather, directions, and character of wind, rain, fog, &c. are furnished by these light-house stations monthly.
West Point }	49 52	64 32	
Cape Magdalen - -	49 16	65 20	
Cape Chalte - -	49 6	66 45	
Point des Monts - -	49 20	67 22	
Bicquet - - -	48 25	68 53	

All Stations report as to Thunder, Lightning, Aurora, Seasonal Events, &c.

Meat Cove, C.B. - -	46 58 ?	60 26 ?	Reports are received by telegraph twice daily from these stations as to weather, wind, fog, and ice in the spring of the year.
Etang du Nord - -	47 24	61 57	
Grosse Isle, N. extremity of Magdalen Island.	?	?	
Amherst Isle - -	47 13	61 58	
East point Anticosti -	49 5	61 43	
West point Anticosti -	49 52	64 32	
Cape Rosier - -	48 52	64 12	

Organization of stations.

3. At each station of the First Order there is a superintendent and two or three assistants, paid from the Central Office.

The stations of the Second Order are for the most part unpaid, and no regular assistants are employed except at a few stations in connexion with the telegraph system. The hours of observation at these stations are 7h. a.m., 2h. p.m., and 9h. p.m., local time, except where otherwise stated in the above list. (See 2.)

The Stations of the Third Order are all volunteer stations, and except where otherwise stated in the above list, the observations are only of rain and general phenomena, the measurements for rain being taken at 7h. a.m.

The Instructions supplied to the observers are those issued by this office. They agree substantially with there commendations of the Vienna Conference.

The psychrometrical tables employed are taken from the Smithsonian meteorological tables, except those for the humidities at low temperatures, which have been calculated in the Central Office for every tenth of a degree of difference between the wet and dry thermometers from the data given by Regnault in his "Rélations des Expériences."

The reduction of the barometer to sea-level is effected by means of tables calculated for each station (generally for every second degree of temperature and every two-tenths of an inch of the barometer) by means of the formulæ contained in a paper "On the Reduction of the Barometer to Sea-Level," by Charles Carpmael, which are based on La Place's formulæ, the barometric constant being taken as 60345·51 English feet, and the coefficient for the expansion of air as $\frac{1}{459}$.

On the receipt at the Central Office, the weekly and monthly abstracts from the different stations are subjected to an examination

(i.) As to any apparently improbable entries,
(ii.) By comparison with other stations,
(iii.) As to the proper application of index correction, reduction to 32°, and sea-level, and ordinary arithmetical errors.

Special observations.

4. Special observations, such as of thunderstorms, hail, periodical

phenomena, the return of the seasons, &c. are taken at all the above 183 stations.

Marine observations. Weather telegraphy.

5. No observations at sea.

6. Telegraphic reports are received in cypher at the Central Office three times a day of the readings of the barometer (reduced to sea-level), the temperature of the air, the dew-point, the state of the weather, the direction and velocity of the wind, the kind, amount, and direction of motion of the upper and lower clouds, the amount of rainfall during the preceding eight hours, and in the morning the lowest temperature since last report.

The stations in Canada which send the three reports are Sydney, Halifax, and Yarmouth, N.S., Chatham, N.B., South-West Point, Anticosti, Father Point, Quebec, and Montreal (Quebec), Rockliffe, Kingston, Toronto, Port Stanley, Saugeen, Parry Sound, Prince Arthur's Landing (Ont.), Winnipeg (Man.), and Charlottetown (P.E.I.), send the morning report only. Telegrams are also received every morning from seven stations on the Gulf of St. Lawrence, giving the direction and estimated force of the wind and the state of the weather; in the spring the amount and direction of flow of the ice is added. These seven stations are—Meat Cove, N.S., Etang Du Nord, Grosse Isle, Amherst Island in the Magdalen Islands, East Point and West Point, Anticosti, and Cape Rosier, Quebec.

In addition to these reports from Canadian stations, reports are received in the morning from 61, in the afternoon from 44, and in the evening from 49 stations of the United States Signal Service.

The observations on which these reports are based are taken at 6.50 a.m., 2.50 p.m., and 10.50 p.m., Toronto civil time.

The reports as soon as received are charted, and probabilities made out for the ensuing 24 hours; and in cases where it is deemed practicable the probabilities have been extended for two or three days. The probabilities made out at midnight are given to the Associated Press for publication in the morning papers, and are also posted up at every telegraph office and railway station in the country (about 1800). A sufficient number of the bulletins for the purpose of verification after having been posted are forwarded to the Central Office with a short notice on the back showing how far the actual weather experienced has agreed with the forecasts. The probabilities made out from the morning map are forwarded to the Associated Press for publication in the afternoon papers. Those made out from the afternoon map are not published, the reports being only used for purposes of storm warnings and for answers to special inquiries.

Warnings of storms are issued when deemed necessary to the following ports:—

Inland Lakes Stations.

Collingwood.	Port Dover.
Midland.	Port Culhorne.
Owen Sound.	Port Dalhousie.
Presqu' Isle.	Burlington Beach.
Saugeen.	Oakville.
Kincardine.	Port Credit.
Bayfield.	Toronto.
Goderich.	Cobourg.
Tanna.	Port Hope.
Port Burwell.	Kingston.
Amherstburg.	Picton.
Port Stanley,	Deseronto.

St. Lawrence River and Gulf.

Montreal.	Chatham.
Quebec.	Charlottetown.
Father Point.	Picton.
Gaspé.	Point du Chêne.
Persé.	Dalhousie.
Bathurst.	

Atlantic Sea Coast.

North Sydney.	Liverpool.
Louisburg.	Yarmouth.
Cow Bay.	Digby.
Glace Bay.	St. Andrews.
Port Hastings.	Point le Preaux.
Halifax.	St. John.

The warnings are signalled by means of drums and cones, and are arranged to indicate the direction as well as the force that is expected as per code appended hereto. In addition to this publication by signal, written notices are posted giving more detailed information as to the expected changes in the wind and weather.

Directions to Mariners with reference to Canadian Storm Warnings, issued for Quebec and the Maritime Provinces.

Fig. No. I., Cone inverted.—This signal indicates "*moderate gale* is expected probably *at first* from an easterly direction."

Fig. No. II., Cone upright.—This signal indicates "*moderate gale* is expected probably *at first* from a westerly direction."

Fig. No. III., Drum above inverted cone.—This signal indicates "*Fresh to heavy gale* is expected probably *at first* from an easterly direction."

Fig. No. IV., Drum below upright cone.—This signal indicates "*Fresh to heavy gale* is expected probably *at first* from a westerly direction."

The *Cone*, when hoisted by itself, indicates that it is expected that the wind will attain a velocity of 30 miles an hour, but will not exceed 40 miles; and it is not intended than an ordinarily well found vessel should stay in port, but simply as a warning to mariners that strong winds are expected from the quarter indicated.

The *Drum* will always be hoisted when the velocity of the wind is expected to exceed 40 miles an hour.

The night signal, corresponding to Nos. 1 and 3, is two white lanterns *hanging perpendicularly.*

The Night signal, corresponding to Nos. 2 and 4, is two white lanterns *hanging horizontally.*

Note I.—Mariners will be able to obtain further information from Drum Agents, or by consulting the daily probabilities.

Note II.—Mariners must always bear in mind that the storm signals are merely *cautionary* and do not necessarily mean that a storm will occur at the place where the signal is displayed, but that one is expected either there or within such a distance that vessels leaving port would be liable to be caught in it.

Note III.—The new signals will be issued and used at all Canadian Storm Signal Stations in Quebec and the Maritime Provinces on and after July 15 next.

C. Carpmael.

Meteorological Office,
Toronto, July 1, 1882.

During the winter warnings, are telegraphed to the managers of all the railways in the country, when heavy snowstorms or much drifting of

snow is expected. Occasionally during the harvesting season extended predictions have been issued for the benefit of farmers for as much as three days in advance.

The Central Office.

7. The Central Office of the system is stationed at Toronto.—The staff consists of a superintendent, deputy superintendent, three observers, an inspector, two probability officers, one photographer, and three clerks, besides office boys, who are employed in copying, and a messenger. There are also two telegraphic operators.

The office is situated in the grounds of the Magnetic Observatory, the director of which is also the superintendent of the meteorological system. The three observers above mentioned are also on the observatory staff.

There are no subordinate centres for management and collection of observations, the whole of the observations being sent direct to the Central Office, where all the work is supervised, sums and means obtained, and results compiled for publication. The Central Office also undertakes to supply instruments and stationery to all stations of the system. The instruments are tested and compared with standards at the observatory.

The Staff.

8. The pay of the staff at the Central Office is as follows:—

	$
*Superintendent - - - -	400·00
3 Observers, $500, 400, $300 - -	1200·00
Deputy superintendent - - -	1000·00
Inspector - - - -	800·00
2 Probability officers, $700 and $680 -	1380·00
Photographer - - - -	570·00
3 Clerks, $500, $550, $432 - -	1482·00

At first-class stations the pay for superintendent and assistants varies from $740 to $400.

Publications.

9. The publications issued by the Central Office are:—

"Monthly Weather Review."
"Annual Report."
"Annual Comparative Table."

In addition to these, monthly and quarterly tables are compiled in the Central Office for the Ontario Bureaus of Industries, and a weekly resumé for the Board of Health, which tables are published in the reports of these bodies.

The independent publications of the principal stations are:—

Montreal, monthly abstract of principal daily readings.
St. John N.B., annual statement.
Halifax do. do.
Charlottetown do. do.

Management and inspections.

10. The control of the whole system is entrusted to the superintendent, and the stations are inspected as often as is found practicable, either by the superintendent, deputy-superintendent, or inspector. The stations in British Columbia, Manitoba, and the far North West, with the exception of Fort Garry, Minnedosa, Oak Lake, Stoney Mountain, and Rapid City, have never been inspected; the instructions having been given entirely by the printed volume, supplemented by letters when necessary.

Historical.

12. Historical Summary (1869 to 1871).—In the latter part of the year 1869, Professor Kingston, Director of the Magnetic Observatory, Toronto, addressed himself by letter and circular to those already taking

* The superintendent also receives a salary as Director of the Magnetic Observatory, and the three observers are likewise on the observatory staff.

meteorological observations in various parts of the country, and to those thought likely to take part in the work, requesting their co-operation with a view to organising some regular system.

From October 1869 until the spring of 1871 meteorological work in Canada was carried on by volunteer organisation, and the instruments were either provided from private sources, or lent from the observatory, Toronto. The work of organising new stations as well as of discussing and compiling the observations was performed gratuitously by the director and assistants of the observatory.

(1871).—In the spring of 1871 a grant of $5,000 was obtained from the Government; the greater part of this was appropriated in the establishment of five chief stations, the remainder to the purchase of instruments for ordinary stations, and for stationery, printing instructions, forms, &c. This grant was afterwards supplemented, and the total expenditure for the fiscal year ending June 30th, 1872, amounted to $7,870.

(1872.) In the year 1872 a few stations began to report three times a day to Toronto by telegraph. These reports, together with that from Toronto, were forwarded regularly by telegraph to Washington, and in return reports from 15 stations in the United States were forwarded to Toronto. The Washington office also undertook to furnish warnings of storms approaching the inland lakes and the Canadian Sea Coast.

The Parliamentary grant for the year ending June 30th, 1873, was $10,000.

(1873.) Three stations in Canada were added in 1873 to the list of those reporting by telegraph to Toronto, and the reports from the United States were received twice, instead of once a day.

The Parliamentary vote for the year July 1st, 1873, to July 1st, 1874, was $37,000,

(1874.) In 1874 thirty-five stations were provided with masts and drums for the display of storm-warning signals.

(1876.) During the summer, and until the close of navigation, a weather chart was issued daily, and was posted up at the Marine Exchange Board, Toronto.

In the beginning of September 1876, arrangements having been made with the Chief Signal Officer, Washington, whereby reports from a much larger number of stations in the United States were forwarded to Toronto three times a day, this office began to issue its own warnings instead of depending upon the Washington Office.

Daily forecasts were regularly furnished to the Toronto papers from October of this year, and from December to the telegraph companies, who forwarded them to the various newspapers in Ontario and in Montreal.

(1877.) In January 1877, a "Monthly Weather Review" was first issued towards the end of the year, the daily weather forecasts were furnished by telegraph to 95 stations in various parts of the Dominion.

(1880.) On January 31st, 1880, Professor Kingston, who had had the superintendence of the service from its first establishment, was compelled through failing health to retire, and was succeeded by Mr. Charles Carpmael. During 1880 arrangements were made with several railway companies for posting forecasts at all their stations; and with others for posting them at their principal stations only. The number of telegraph offices at which the forecasts were posted was also increased to 300, and, for the first time, predictions, extending over two or three days, were issued for the benefit of farmers.

(1881.) In July 1881, a system of storm warnings was inaugurated on the inland lakes, whereby the direction as well as the approximate force of the wind is indicated.

(1882.) In 1882 arrangements were made with telegraph companies whereby forecasts issued at midnight are posted early in the morning at every telegraph station (about 1,800) in the country. In the month of July of the same year the new system of storm warnings was extended to the sea-coast. These measures greatly increased the interest taken by the public in the work of the office, and the number of volunteer observers has since been rapidly and steadily on the increase.

The Parliamentary vote, which had been for several years $37,000, was for the fiscal year beginning July 1882 increased to $40,000.

GREAT BRITAIN AND IRELAND. COLONIES. B.—CAPE OF GOOD HOPE.

W. Ellerton Fry, Esq., Meteorological Commission, Cape of Good Hope.

At the request of the members of the Meteorological Commission I beg to send you the following information in reply to your circular of 31st December 1882:

Definition of system.

1. The Meteorological Commission is an honorary body appointed by the Colonial Government. The funds at the disposal of the Commission were until recently 250*l.* per annum, which small sum had to suffice for purchase of instruments and salary of secretary. During the last three years an extra sum of 250*l.* per annum has been voted to enable the secretary to make a tour of inspection of stations, and in 1882 a special vote of 100*l.* was made to defray the expense of purchasing some self-recording instruments. Many of the rain-gauge stations are at gaols, and the gaoler is instructed by Government that it is part of his duty to read the gauge.

The meteorological system in Cape Colony consists of (i.), our well-equipped station, the Royal Observatory supported by the Imperial Government. (ii.) A varying number of stations in the colony supplied with instruments by the Meteorological Commission of the colony. (iii.) A large number of stations supplied by the Crown Lands and Public Works Department, with rain-gauges only.

Number and position of stations.

2. The geographical positions are given in the Annual Report of the Meteorological Commission.

Organization of stations.

3. Hours of observation at Royal Observatory, 6h. a.m., 1h.22m. p.m., and 10h. p.m.; elsewhere generally 8h. a.m. and 8h. p.m. Copy of instructions to observe is enclosed herewith. Some tables of reduction are given in the annual report.

Weather telegraphy.

6. Under consideration.

The Central Office.

7. The Royal Observatory is, by permission of the Astronomer Royal of the Cape, the Central Office.

The staff.

8. The observers gave their services *gratis*.

Publications.

9. The Commission publish a report once a year. The late Astronomer Royal here, Mr. Stone, published results of the records of the Royal Observatory.

Management and inspections.

11. The secretary of the Commission inspects as far as practicable all stations once a year.

Historical.

12. From 1862–1868 a Commission was in existence which published reports. From 1868–1875 the Commission did not print any report. The present system began in 1875 and the annual reports if examined consecutively show a progressive increase in number of observations. Since the organisation of inspection it is believed that the quality of the observations has been improved.

GREAT BRITAIN AND IRELAND. COLONIES. C.—CEYLON.

J. Stoddart, Esq., Surveyor General's Office, Colombo, Ceylon.

Definition of system.

1. Complete meteorological observations are taken at thirteen stations in Ceylon; three of which are inland hill stations, two inland stations in the low country and eight coast stations. Partial observations are taken at one inland station on the plains. Rainfall only is registered at 55 stations. These observations are forwarded monthly to the head office in Colombo where the monthly averages are tabulated and published.

Number and positions of stations.

2. The whole of the Ceylon stations are of the Second Order, and are situated as follows:—

——	Lat.	Long.	Height.	—
	° ′	° ′	Feet.	
Colombo	6 56	N. 79 59 E.	40	Coast.
Ratnapura	6 42	„ 80 24 „	109	Inland.
Puttalam	8 2	„ 79 50 „	11	Coast.
Anuradhapura	8 22	„ 80 23 „	312	Inland.
Mannar	8 59	„ 79 55 „	12	Coast.
Jaffna	9 40	„ 79 56 „	9	„
Trincomalee	8 33	„ 81 15 „	175	„
Batticaloa	7 43	„ 81 44 „	26	„
Hambantota	6 7	„ 81 7 „	40	„
Galle	6 1	„ 80 14 „	48	„
Kandy	7 18	„ 80 40 „	1,650	Hill.
Nuwara Eliza	6 59	„ 80 5 „	6,240	„
Badulla	6 59	„ 81 5 „	2,225	„
Vavonia Vilan Kulam	?	?	?	Inland.

Organization of stations.

3. The observations taken daily at 9h.30m. a.m. and 3h. 30m. p.m., are entered into a rough book from which the monthly sheet, almost similar to the form published in Colonel Sir Henry James' Instructions for taking Meteorological Observations, is prepared. Instructions prepared by Colonel Fyers, R.E., are supplied to the observers. Glaisher's tables are used for the reduction of the observations.

The rough books and monthly sheets are forwarded to the head office at Colombo, where they are checked and compared.

Special observations.

4. Thunderstorms and other phenomena are noted in the remarks attached to the monthly sheets. A complete return of thunder and lightning seen or heard at Colombo, is forwarded monthly to Mr. G. J. Symons, of 62, Camden Square, London.

Weather telegraphy.

6. Daily weather telegrams are forwarded to Simla, from May 16th to October 15th, and to Calcutta, from 16th October to 15th May, at 9½ a.m., from Colombo, Galle, and Trincomalee, by the ordinary Government service.

Daily weather telegrams are forwarded to the General Post Office at Colombo from 10 stations, viz., Colombo, Anuradhapura, Mannar, Jaffna, Trincomalee, Batticaloa, Galle, Kandy, Nuwara Eliza, and Badulla, and published by the Government in the Daily Postal List, and in the local newspapers.

The Central Office.

7. The Central Office is the Surveyor General's Office at Colombo, containing the following instruments, viz.:—

One standard barometer with a thermometer attached.
Do. do. thermometer.
Do. ordinary maximum thermometer.
Do. do. minimum do.
Do. maximum wet do.

One minimum wet thermometer.
Do. solar radiation do.
Do. terrestrial radiation do.
Do. Ozone cage.
Do. rain-gauge.
Do. wind-vane.
Do. Robinson's small anemometer.
Do. Casella's enlarged self-registering anemometer.

All the above thermometers and barometer have been tested at either Kew or Greenwich Observatories, and all the instruments, which are issued from the head office to subordinate stations, are compared and the corrections noted.

The instruments at all the subordinate stations are similar to the instruments at Colombo, except the anemometers, which are non-registering, and the standard thermometer, which is not required.

The staff.

8. At the head office the staff consists of one paid observer at Rs.300 per mensem, and two other volunteers belonging to the Surveyor-General's department, under the superintendence of the Surveyor-General.

The salary of the observers at subordinate stations is Rs.10·00 a month, except Trincomalee, Rs.15·00.

Publications.

9. The following publications are issued at the Central Office :—

A monthly abstract of meteorological observations of all the stations.

An annual and average return of Rainfall, and the number of days in which rain fell.

Complete annual reports for 1881 and 1882, containing the averages for the last 14 years, are in the hands of the Government printer for publication.

The temperature in the monthly abstracts is the maximum and minimum observations, and the hygrometrical reductions are obtained by Glaisher's tables.

The temperature in the annual reports is the mean of the 9·30, 3·30 and minimum readings, and the hygrometrical reductions are obtained by the tables attached to the Indian Meteorologists Vade Mecum. The reason for this difference is caused by the annual reports for this island being prepared in connexion with the Annual Report on the Meteorology of India, published for the last seven years by the Indian Government.

Management and Inspections.

10. The stations are inspected whenever possible by the Surveyor-General, or one of his assistants.

Historical.

12. Meteorological observations in Colombo were first systematically instituted by Colonel Fyers, R.E., Surveyor-General of Ceylon, in the year 1869, and gradually extended under his supervision throughout the island.

J. Stoddart,
Acting Surveyor-General of Ceylon.

Surveyor-General's Office,
Colombo, March 10, 1883.

GREAT BRITAIN AND IRELAND. COLONIES. D.—NEW ZEALAND.

A reply has been received from Dr. J. Hector, F.R.S., Wellington, New Zealand. It does not contain much more information than the account of the Melbourne Conference. App. V., p. 20.

ITALY.—ROME.

M. P. Tacchini, Central Meteorological Office, Rome.

Definition of system.

1. The meteorological service in Italy is distributed according to provinces, and as the provinces are 69 in number, as many observatories of the First Order * have been established; to these is entrusted the care of the observations which are made at all the other stations in the respective provinces. In this manner all the observations are collected by the observatories of the First Order, and are then forwarded to the Central Office.

Number and position of stations.

2. The number of stations of the First Order is 69, of the Second Order 37; those of the Third Order (at which only observations of rain and temperature are made) have reached the number of 400. Annexed is a list giving the geographical positions of the 69 stations of the First Order.

CENTRAL METEOROLOGICAL OFFICE, ROME.

Geographical positions of the Stations of the First Order.

No.	Stations.	Lat.	Long. from Rome.	—	Height above Sea.
		° ′	° ′		Feet.
1	Sondrio - - -	46 10	2 35	W.	1191
2	Belluno - - -	46 8	0 15	„	1325
3	Udine - - -	46 4	0 44	E.	381
4	Como - - -	45 48	3 22	W.	—
5	Bergamo - - -	45 42	2 48	„	1254
6	Treviso - - -	45 40	0 16	„	84
7	Vicenza - - -	45 33	0 57	„	182
8	Brescia - - -	45 32	2 16	„	564
9	Novara - - -	45 30	3 54	„	551
10	Milan - - -	45 28	3 18	„	483
11	Verona - - -	45 26	1 28	„	217
12	Venice - - -	45 26	0 9	„	69
13	Padua - - -	45 24	0 39	„	101
14	Pavia - - -	45 11	3 20	„	321
15	Mantua - - -	45 10	1 42	„	131
16	Cremona - - -	45 8	2 26	„	222
17	Turin - - -	45 4	4 48	„	904
18	Rovigo - - -	45 3	0 42	„	30
19	Piacenza - - -	45 3	2 49	„	235
20	Alessandria - -	44 54	3 52	„	321
21	Ferrara - - -	44 51	0 52	„	49
22	Parma - - -	44 48	2 10	„	292
23	Reggio Emilia - -	44 42	1 51	„	202
24	Modena - - -	44 39	1 33	„	211
25	Bologna - - -	44 30	1 9	„	277
26	Ravenna - - -	44 25	0 15	„	—
27	Genoa - - -	44 24	3 34	„	178
28	Cuneo - - -	44 23	4 57	„	1820
29	Forli - - -	44 13	0 27	„	160
30	Massa - - -	44 4	2 18	„	—
31	Pesaro - - -	43 55	0 24	E.	45
32	Porto Maurizio - -	43 53	4 26	W.	206
33	Lucca - - -	43 51	1 58	„	101
34	Florence - - -	43 46	1 14	„	238
35	Pisa - - -	43 44	2 5	„	33
36	Ancona - - -	43 37	1 2	E.	99
37	Leghorn - - -	43 33	2 11	W.	78

* These can hardly be termed stations of the First Order, as defined by the Vienna Congress, as the observations are only made three times a day.—ED.

CENTRAL METEOROLOGICAL OFFICE, ROME.—*continued.*

No.	Stations.	Lat.	Long. from Rome.	—	Height above Sea.
		° ′	° ′		
38	Arezzo - - -	43 27	0 36	W.	899
39	Siena - - -	43 19	1 10	,,	1143
40	Camerino (Macerata) -	43 8	0 35	E.	2177
41	Perugia - - -	43 7	0 6	W.	1706
42	Ascoli Piceno - -	42 54	1 6	E.	544
43	Grosseto - - -	42 45	1 24	W.	103
44	Teramo - - -	42 40	1 14	E.	938
45	Chieti - - -	42 22	1 42	,,	1118
46	Aquila - - -	42 21	0 55	W.	2411
47	Rome - - -	41 54	0 00	,,	163
48	Agnone (Campobasso) -	41 48	1 53	E.	2625
49	Foggia - -	41 27	3 2	,,	287
50	Bari - - -	41 9	4 22	,,	—
51	Benevento - - -	41 7	2 19	,,	558
52	Caserta - - -	41 3	1 53	,,	250
53	Avellino - - -	40 56	2 16	,,	1214
54	Naples - - -	40 52	1 46	,,	489
55	Salerno -	40 42	2 16	,,	172
56	Sassari - - -	40 40	3 19	W.	704
57	Potenza - - -	40 39	3 19	E.	2717
58	Lecce - - -	40 22	5 43	,,	236
59	Cosenza - - -	39 19	3 48	,,	839
60	Cagliari - - -	39 13	3 23	W.	115
61	Cantanzaro - -	38 55	4 18	E.	1066
62	Messina - - -	38 12	3 4	,,	87
63	Reggio Calabria - -	38 8	3 10	,,	59
64	Palermo - -	38 7	0 52	,,	237
65	Trapani - - -	38 3	0 3	,,	88
66	Catania - - -	37 30	2 34	,,	102
67	Caltanissetta - -	37 20	1 33	,,	1871
68	Girgenti - -	37 16	0 54	,,	837
69	Syracuse - - -	37 3	2 46	,,	71

anization of ions.

3. At the stations of the First and Second Order the hours of observations, are 9h. a.m., 3h. and 9h. p.m., and the observations include barometer, thermometer, humidity, evaporation, direction, and force of wind, rain, state of the sky, and of the sea.

Most of the directors of stations of the First Order are professors of physics at the Government educational institutions, who, like the others, follow the printed and written instructions which are furnished to them by the Central Office; the same may be said of the tables of reduction, which are partly those published in the "Annuaires Météorologiques" of France and partly those edited by Mr. A. Guyot, entitled "Tables Meteorological and Physical," Washington, 1859. Some of these tables however have been notably amplified and modified.

The checking of the observations is carried out by means of proper inspections, on which occasions also the instruments are compared with the inspector's standards which are taken with him. Every station of the First and Second Order is, on an average, inspected every two years.

ecial observa- ns.

4. A special service for the observations of thunderstorms is organised in every province. This is done by means of cards (like post cards) a specimen of which is annexed, and which are distributed in every province by the directors of the observatories, who after having collected them, duly filled up, forward them to the Central Office.

(Copy of Post Cards).

Address { Thunderstorm Service. / To the Meteorological Observatory / of.....

Particulars { Province..... / Station..... / *Thunderstorms.* / Day month year. / Began at hours minutes. / Ended at „ „ / Direction of the storm. / Winds. / Did the thunderstorm occupy all the visible sky ? / Rain. Hail.

Notes.

In 1882 the Central Office received 7,767 cards, distributed as follows :

Upper Italy	- 31 provinces	-	5,418 cards.
Central Italy	- 16 „	-	919 „
Lower Italy	- 22 „	-	1,430 „

To this number of 7,767 cards must be added all the other observations of thunderstorms recorded in the forms of meteorological observations, made at Stations of the First and Second Order, so that altogether we may reckon that for the year 1882 the number of observations reached 9,000.

The service of phenological observations was not organised in 1882.

5. Maritime observations are made by some harbour masters and at some semaphore stations. Marine observations.

6. For the daily telegraphic service, the Central Office receives every day meteorological telegrams from the following stations : Weather telegraphy.

From Italy	-	44 in number.
„ Russia	-	6 „
„ Austro-Hungary	-	10 „
„ Bavaria	-	4 „
„ France	-	5 „
„ Algeria	-	4 „
„ Switzerland	-	4 „
„ Iberian-Peninsula	-	4 „
„ Malta	-	1 „
„ Constantinople	-	1 „
„ London	-	1 „
Total	-	84

The Central Office of Rome sends every morning by telegraph the observations from nine Italian stations and those from Malta to the central offices of St. Petersburg, Vienna, Munich, Zürich, Paris, Trieste, Madrid, and Constantinople.

After the construction of the meteorological chart for the day, the daily meteorological telegram is compiled from the observations collected, and is generally sent a little after 2h. p.m. to 37 stations, including observatories and harbour masters, and to 34 semaphores.

Special telegrams are also sent to the semaphores at any hour according to need, and are also requested in special conditions of weather. After reduction and study of the data, the meteorological bulletin, on four pages, is published every day, containing isobars for Europe for every five millimetres, and further details separately for Italy. This bulletin was, and is, sent the same day to all correspondents.

entral

7. The Central Office is the only one in the Kingdom, and is situated at Rome, at the Collegio Romano, and is attached to the observatory of the same college.

All the instruments are compared with the standards at the Central Office, and are afterwards distributed to the stations. Some of these instruments, such as anemometers, anemoscopes, evaporators, meteorographs, hygrometers, &c., are constructed in the workshop annexed to the Central Office itself, under the superintendence of MM. Brassart Brothers.

aff.

8. The *employés* of the system are paid from the funds allotted in the accounts of the State, of the provinces, of municipalities, and of some corporate bodies, such as Academies, &c., as well as from some private sources. The Central Office grants only subsidies and allowances, which amount to 400*l.* a year.

cations.

9. The Central Office publishes the following :—

Annalia della meteorologia italiana.
Bullettino mensile internazionale.
Bullettino meteorico agrario decadico.
Bullettino meteorico giornaliero.
Rivista meteorologica mensile.

And also readily publishes any original meteorological memoirs which are communicated to it by the directors of Italian observatories. It sends also every month the simultaneous observations requested by the Washington Office.

The following stations:—Turin, Moncalieri, Milan, Genoa, Vicenza, Venice, Pesaro, Ancona, Foggia, Lecce, Naples, Salerno, Palermo, Syracuse, Potenza, Porto Maurizio, and Lucca publish special bulletins and meteorological annals.

gement
spections.

10. Mention has been made under point 3 of the inspection of the observatories; every observatory has its own administration, dependent upon the corporate body to which it belongs. The expenses for the purchase of instruments are almost all borne by the Central Office, which is under the Ministry of Agriculture, Industry and Commerce.

lementary
ks.

11. The applications for the establishment of new stations, for obtaining instruments, or grants of money must be made to the Central Office, which submits them for the approval of the Superintending Council, who hold their meetings at the same office.

rical.

12. With respect to the historical *résumé* of the meteorological service in Italy, see the introduction to vols. I. and II. (Part 1.) of the Annals for the years 1879 and 1880.

ITALY.—NAPLES.

M. A. de Gasparis, Royal Astronomical Observatory, Naples.

As Director I reply to your circular. The observatory of Naples, at Capodimonte, was at its origin destined for astronomical observations. If the institution has rendered some service to Meteorology, it has been owing to the appointment of Professor Brioschi to this important branch of research and his singular aptitude for it.

Professor Brioschi has published, with my assistance, during the space of upwards of 18 years a valuable series of meteorological observations, which, having been made by him with the greatest care, are sufficient for the determination of local means. Besides the barograph and thermograph observations obtained every 15 minutes for all the 24 hours, and published for each hour without interruption for more than 12 years, they will furnish data for important researches.

Professor Brioschi, who has indefatigable activity and zeal, is the *only* person who is occupied with Meteorology in the observatory. All the other *employés* are entirely occupied with astronomical duties. It is clear therefore that the observatory of Naples cannot be a meteorological station taking part in the observations which are required. In fact, it would be necessary to appoint quite a staff of observers for meteorology, which certainly cannot be done at the Naples Observatory, although it is seen that at Paris, Vienna, Berlin, and St. Petersburg the astronomical observatories are separate and rendered independent of the meteorological observatories, because the latter have developed greatly. and have required great expenditure.

Professor Brioschi has hitherto worked enough for Meteorology. The observatory wishes to utilize his valuable services as an observer in getting him to carry on magnetic observations with greater completeness. The two Gauss's magnetometers readjusted by him, Barrow's dip instrument already purchased and at work, and the declinometer already ordered in London, will give Professor Brioschi sufficient occupation for himself and two astronomical assistants.

I wish that this reply should have some publicity, so that any doubt may be removed.

THE NETHERLANDS.

Professor Buys Ballot, Royal Meteorological Institute, Utrecht.

1. The Dutch meteorological system has aimed from the beginning at combining reliable observations over the world with each other, and thus showing the disturbances of the atmosphere and their mode of propagation, and at obtaining from the logs of merchant vessels statistical results as to the best routes. Definition of system.

2. Two stations of the First Order, Utrecht, lat. 52° N. long. 0° 11′ E., and Helder, lat. 52° 56′ N., long. 4° 45′ E. ; five of the Second Order, Groningen, Leeuwarden, Flushing, Maastricht, Hellevoetsluis ; and four of the Third Order, Amsterdam, Assen, Delfzyl, Tilburg. Number and position of stations.

3. There is nothing particular to be said about the organization. The hours of observation are 8 a.m., 2 and 8 or 10 p.m. The tables of reduction are Guyot's. A check is continually made by comparisons, it being a very severe test that every month in the "Afwykingen" the observations of every station are placed next to those of the other stations. As soon as a doubtful observation has been detected, inquiry is made, and an inspection follows. Organization of stations.

Special observations.

4. We have 50 rain stations, which also record hail, snow, wind (force and direction), with the exact time of beginning and ending. Also a large number of thunderstorm observers, who in some cases exceed 300. Forms are distributed all over the country containing a number of definite questions, the answers to which are all that is required, and the forms are sent through the post, free of charge.

Marine observations.

5. At sea the usual observations are recorded. The men-of-war take them in full; we have only asked those merchant captains to observe who are likely to send observations which will be of practical use. The observations required are the ship's position at noon, the dead reckoning, direction of currents, barometer, wind, temperature of the seawater, and cloud.

Weather telegraphy.

6. Telegrams are received three times a day; at 8 o'clock a.m. from 26 foreign places; at 12.30 and 7 p.m. from the four stations at the extreme points of the kingdom.

Intelligence is sent every morning and again in the evening to the ports. The warning notices are telegraphed in three groups of five figures, some of which have a conventional signification known to the receivers. These telegrams are sent to the newspapers and to the ports. At the latter the telegrams are converted and publicly exhibited.

The Central Office.

7. The Central Office is at Utrecht; there is a subordinate marine section at Amsterdam under Mr. van Hasselt, which has been established more particularly for the benefit of the seafaring community; and one at the Helder, where an observer has care of all the registering instruments. Instruments are supplied from Utrecht.

The staff.

8. The staff is composed of Dr. Snellen, Baron van Heerdt, and Mr. van Hasselt, who receive a salary of 200*l.* each. Observers and clerks have a salary of 42*l.* to 100*l.* The observers are volunteers, directors of middle-class schools, &c. The only person who receives anything like a salary, say 63*l.*, is M. Zaatman at Helder.

Publications.

9. Publications are only issued from Utrecht and Amsterdam.

Management and inspection.

10. As already stated, in this small country inspections of the stations are seldom made, except when the continual check kept upon the observations shows that they are wanted.

Historical.

12. It is only necessary to compare the different volumes of the Jaarboek to see how the publications fulfil the principal requirements more and more each year.

In the first place Part II. of the volume gives the normal values of pressure, temperature, rain, for many places in the northern hemisphere. In Part I. the climatology of the Netherlands is attended to.

The publications of the marine section show the best tracks of ships for the routes followed by Dutch ships, and also contain barometer heights and wind (direction and force), storms, thunderstorms, and rain in the Atlantic and Indian Oceans.

Telegraphic warnings were proposed in 1857 and adopted and issued on the 1st of June 1860.

NORWAY.

Professor H. Mohn, Norwegian Meteorological Institute, Christiania.

Definition of the system.

1. The Norwegian Meteorological Institute.

Number and positions of stations.

2. First Order, 1 (Christiania), Lat. 59° 55′ N., Long. 10° 43′ E.
„ „ Second Order 33.
„ „ Third „ 15.

3. *Outfit of the Station of First Order.*—A barograph by Höttinger, a thermograph by Rung, a standard barometer by Negretti and Zambra, Wild's thermometer screen, dry and wet bulb thermometers, minimum and maximum thermometers, Wild's wind-pressure plate, Robinson's cup and dial and anemometer, modified by Mohn, a rain and snow gauge. Organization of stations.

Outfit of Stations of Second Order.—A Kew Barometer (at two stations a Fortin's barometer); dry and wet bulb thermometers (thermometers by Aderman, metal screen); a minimum thermometer (*see* "Grundzüge der Meteorologie," third edition, page 93); a spare thermometer; Wild's wind-pressure plate (stations; a rain gauge and snow gauge (*see* "Grundzüge der Meteorologie," 3rd edition, page 187); an aneroid barometer as a check instrument.

Outfit of Stations of the Third Order:—

(*a.*) *Lighthouse Stations.*—Thermometers in a cylindrical zinc screen, minimum thermometer screened, aneroid barometer, water thermometer, Wild's wind-pressure plate, spare thermometer.

(*b.*) *Climatological Stations.*—Ordinary thermometers and minimum thermometer, with screen same as (*a.*). (Some have dry and wet bulb thermometers.) Rain and snow gauges. The wind is observed without an instrument.

Hours of Observation.—Generally 8 p.m., 2 p.m., and 8 p.m. Instructions printed in Norwegian, drawn up according to the decisions of the Meteorological Congresses and of the International Committee. Guyot's tables for barometer, Jelinek's for dry and wet thermometers.

Checking of the Observations.—All the observations are revised and reduced at the Meteorological Institute. The barometer observations are checked in the following way (*see* "Jahrbuch" of the Norwegian Meteorological Institute for 1876, p. ix.):—All the barometer observations of each station are plotted upon millimeter (sectional) paper. The horizontal scale is 10mm. for a day, the vertical scale corresponds to the actual extent of the barometer readings. A curve is drawn with a free hand through the points which have been laid down. The curves for a series of stations are drawn underneath each other on the same sheet, so that each station always lies between its two adjacent stations. A glance at the curves exhibit at once the jumps in the series of observations, and show that the observers have made mistakes of 5 mm., 10 mm., 15 mm., 20 mm., and so on. Such obvious errors are corrected in the tables. It is also easy to judge from the agreement between the curves of adjacent stations whether the observations of individual stations are generally trustworthy or not.

Synoptic charts for the whole of Norway are drawn every day from the morning observations, showing the barometer readings, wind, and weather for all stations. The morning observations from Sweden and Denmark which are contained in the "Bulletin du Nord" are also inserted, and sometimes those of the "Daily Weather Report," and some from the "Wetterbericht der Deutschen Seewarte," and the "Russische Bulletin." The isobars are drawn, and accordingly the readings of all our barometers are mutually checked.

General synoptic charts for Norway are drawn each month, containing monthly means of barometer (reduced to sea-level), air temperature and wind force, prevalent wind-direction, and the amount of rainfall. The natural course of the isobaric lines checks the barometer corrections. The accuracy of the absolute amount of the corrections is ensured for most stations by verifications and inspections. How well the Kew barometers maintain their corrections may be seen from the

introduction to the last volumes of the "Jahrbuch" of the Norwegian Meteorological Institute.

The minimum thermometers are checked every day by comparison with the dry-bulb thermometers.

Special observations.

4. Thunderstorms are observed by about 50 special observers, in addition to those at the stations above mentioned. Phenological observations are not made in connexion with the Institute.

Marine observations.

5. The Institute receives about 20 logs yearly. The registers and printed instructions for taking the observations are issued by the Institute, and some instruments are verified there. The observations include barometer, air temperature, sea-surface temperature, wind direction and force, amount of cloud, rainfall, &c. and sea disturbance.

Weather telegraphy.

6. By the assistance of the Telegraphic Administration the morning observations from Bodö, Christiansund, Florö, Skudesnes, Oxö, Sandosund, and Dovre are posted up for public use at all Norwegian ports, which are connected by telegraph at about 10h. a.m.

The Meteorological Institute receives, in addition to these morning observations, evening observations from Bodö, Christiansund, Skudesnes, and Oxö, and morning observations according to the International Code, from Haparanda, Hernösand, Stockholm, and Wisby; from Copenhagen and Fanö; from Dunrossness, Aberdeen, Yarmouth, and Valencia, and also wind and weather observations for the morning hour from Egersund, Ystad, Helsingborg, and Skagen. After receipt of these communications the observations are entered on a chart at noon, isobars are drawn, and the change of pressure since the previous evening is calculated. As soon as a sufficient idea of the situation is arrived at, this, as well as the forecasts for the next day, are made known by publicly posting them up with the weather charts and reports for morning and evening, and the bulletin is communicated to the Christiania newspapers.

The Christiania "Morgenblad" publishes a chart printed from the manuscript of the Institute by Rung's method; the same is also published by the "Bergenspost" at Bergen. If a storm is expected warnings are immediately issued to all places threatened, giving the direction from which the storm will probably blow. This warning is at once forwarded by the telegraph office, and its contents communicated to the harbour authorities, principal pilots, and heads of fisheries, to distribute them further if necessary. Storm warnings are issued from Christiania practically only for the South of Norway. The French telegrams do not arrive before mid-day. The afternoon telegrams from Skudesnes and Aberdeen are also used for storm warnings.

An attempt was made last summer, as an experiment, to warn agriculturists in Smaaldeneue (east of the Christianiafjord) during harvest time; 81 % of the warnings were successful, 9 % partially successful, and 10 % were failures.

The Central Office.

7. The Central Office of the System is at Christiana. The Meteorological Institute belongs to the University. The director is Professor of Meteorology at the University. The first assistant is appointed by the Senatus of the Academy, the others by the Director of the institute. The funds for the institute proposed by the Director to the Senatus and the Government are voted by the *Storthing*. The institute rents an office in the town. The daily observations are made in the park of the Astronomical Observatory by the staff of the institute. In addition to the instruments mentioned under (3), the institute possesses a collection of spare instruments, apparatus for testing barometers and thermometers, deep-sea thermometers, diagrams for lectures, &c.

8. The staff consists of—the director (professor at the University), salary 330*l.*; first assistant, 132*l.*; second assistant, 199*l.*; third assistant, 88*l.*; fourth assistant, 88*l.*; and caretaker, 26*l.* 8*s.* The staff.

Of the observers at the stations 21 receive a yearly remuneration of 7*l.* 18*s.*

9. The annual publications of the Meteorological Institute are :— Publications.

1. Year-book of the Norwegian Meteorological Institute.

2. Meteorological summary for each month, published in the "Agricultural Journal."

3. Summary of the weather in Norway for each year in the same journal.

10. The management is under the University and the director. The stations are inspected often, say every third year, by the director or one of the assistants. This frequency of inspection is found quite sufficient, with the Kew barometers now used and the improved Instructions. Management and inspections.

11. The amount of the annual grant is now 453*l.*, exclusive of the salary of the staff, but including the rent of the institute. Supplementary remarks.

12. The Norwegian Meteorological Institute was established in 1866, and commenced work on the 1st December 1866, after I had made a journey abroad and a tour of inspection to the five stations established in 1860 in Southern Norway, by M. C. Nielsen, Director of Telegraphs. In the following years a number of new stations were established both in Northern and Southern Norway. After the Meteorological Congress at Vienna in 1873 the stations were, by a munificent vote of the *Storthing*, provided with new barometers, thermometer screens, wind-gauges, and rain-gauges. In 1870 the institute published a Storm Atlas. Summaries of the climate of Norway have often been given. Now the whole series of observations from 1861 are being used, after thorough revision, for a more accurate representation of the climate of Norway. The yearly reports of the director to the Senatus of the Christiania Academy, printed in Norwegian, will best show the development of the Institute. Historical.

PORTUGAL.

Captain J. C. De Brito-Capello, Observatory of the Infante D. Luiz, Lisbon.

1. The meteorological system of Portugal comprises the central observatory of the Infante D. Luiz and its network of stations of the First, Second, and Third order, on the mainland, in the Azores and Madeira, and in the territories in Africa and Asia. Definition system.

There is also, independently of the system, a meteorological and magnetical observatory at Coimbra belonging to that University.

The observatory of the *Infante* D. Luiz is at the same time an observatory of the First Order, and a meteorological office, with a system of subordinate meteorological stations.

2. Our stations are arranged in the following way : Number and positions of stations.

Two stations of the First Order :—

——	Lat.	Long.	Height above Sea.
	° ′	° ′	Feet.
Sierra da Estrella - - - - -	40 25 N.	7 35 W.	4,728
Loanda - - - - - - -	8 49 S.	13 7 E.	194

Ten stations of the Second Order:—

	Lat.	Long.	Height above Sea.
	° ′	° ′	Feet.
Montalegre	41 49 N.	7 45 W.	3,281
Nizen	40 39 „	7 57 „	1,949
Guarda	40 32 „	7 14 „	3,409
Campo-maior	39 2 „	6 59 „	945
Angra do Heroismo (Azores)	38 39 „	27 14 „	144
Ponta Delgada (Azores)	37 45 „	25 41 „	66
Funchal, Madeira	32 38 „	16 55 „	82
St. Thomas (Id.)	0 20 .	6 43 E.	16
Macao (China)	22 10 „	113 32 „	46
Goa (Hindostan)	15 28 „	73 55 „	23

Five stations of the Third Order:—

	Lat.	Long.	Height above Sea.
	° ′	° ′	Feet.
Moncorvo	41 10 N.	7 1 W.	1,362
Oporto*	41 9 „	8 35 „	328
Cintra	38 50 „	9 21 „	502
Evora	38 35 „	7 52 „	1,027
Lagos	37 6 „	8 38 „	43

Organization of stations.

We have only on the mainland of Europe one station of the First Order, Sierra da Estrella, which has been quite recently established.

The staff is composed of two observers, one of whom has the management, and of a servant.

The station is provided with ordinary and self-registering instruments for the principal meteorological elements.

The hours of observation are 7h. a.m., 9h. a.m., 11h. 30m. a.m. (Washington simultaneous observation), noon, 1h. p.m., 3h. p.m., and 9h. p.m.

The other station of the First Order is at Loanda; it is managed by a marine officer (harbour-master) assisted by an officer and a petty officer. The hours of observation are 9h. a.m., 11h. a.m. (Washington simultaneous observation), noon, 3h. p.m., and 9h. p.m.

This station, or rather this observatory, is in a special building, at which astronomical observations are made in order to give the exact time to the vessels anchored in the harbour. In addition to the meteorological observations, observations of magnetic declination, dip, and horizontal force are made.

The salaries of the observers are borne by the government of the province.

The stations of the Second and Third Order, although the majority are situated in various establishments, and are under the superintendence of the directors, viz., professors of secondary schools, directors of public works, physicians, &c., yet their assistant-observers follow a common plan, in accordance with the Instructions furnished by this Institution. The appointment of the assistant observers is made by the director of this central observatory, on the nomination of the directors of the stations. The salaries are paid from the vote of this central observatory.

The hours of observation at the stations of the Second Order are generally† 9h. a.m., noon, 3h., and 9h. p.m.

* The construction of a meteorological and magnetical observatory at Oporto has been begun.

† At Montalègre and Guarda the 9h. p.m. observations are omitted, and at S. Thomas the noon observations are omitted.

In addition to these hours, the international stations, Campo-Maior, Angra, Ponta-Delgada, and Funchal take simultaneous observations at 7h. a.m., Washington time.

The hours of observation at stations of the Third Order are 9h. a.m. and 3h. p.m.

The Instructions furnished to the observers at stations of all orders are the same as in use at this central observatory, and in accordance with the decisions of the recent congresses of Vienna and Rome.

The tables for the reduction of barometer readings to 32° F. are those of T. Haeghens. For relative humidity and tension of vapour we employ the hygrometric tables by the same author, printed by the Smithsonian Institution.

The observations are checked at the central observatory by one of the heads of the service, who has charge of the service of the stations, aided by assistants. The registers of the different stations are compared in order to detect the most frequent errors.

All the values of humidity and vapour-tension are re-calculated.

The tables of published monthly observations are arranged and the means calculated at the central observatory.

Special observations.

4. Observations of thunderstorms, hail, &c., are made by the directors of telegraph stations, forest employés, directors of public works, &c. The observations are made on a regular form supplied by this observatory and are quite optional.

We cannot at present state exactly the number of these stations or of the observers. These observations are also of very recent date, having been commenced in October 1882.

We have not yet begun phenological observations.

Marine observations.

5. Meteorological observations at sea are now taken almost on ships of war only. An officer on board is charged with the observations, and is assisted by the cadets. The hours are those adopted at the Maritime Conference at London (1874): 0h., 4h., 8h., 16h. astronomical time.

The instructions are drawn up in accordance with the decisions of the same conference. The instruments are supplied by the Hydrographic Office of the Ministry of Marine, but they are compared with the standards of this observatory.

In addition to these observations, at 7h. a.m., Washington time, are made, principally when the vessels are in port.

The instruments are the following :—

Barometer by Adie.
Aneroid.
3 Thermometers by Casella or Negretti and Zambra.
3 Glass hydrometers do. do. do.

Weather telegraphy.

6. Thirteen stations from this country, three from Spain (Corunna, San Fernando, and Madrid), and nine from France (total 25) send morning telegrams to this observatory. The observations at the stations of this country (continental) are made at 7h. a.m. in summer and at 8h. a.m. in winter.

The telegrams from France, Spain, Funchal, and Sierra da Estrella are composed of groups of five figures, in accordance with the instructions of the Vienna Congress; those from the other stations in this country send telegrams according to the old code.

Generally, during fine weather, the telegrams from the peninsula and from Funchal are received between 11h. a.m. and noon, and those from France before 1h. p.m.

In bad weather, just when the telegrams are most necessary, their arrival is much delayed, and very often a large part of them do not

arrive at all, especially those from France and the more elevated stations of this country.

In favourable circumstances the study of the telegrams, the drawing of the isobars, the forecast of the weather for the following day, and lastly, all the report is written upon transfer paper and sent to the lithographer between 1h. 15m. and 1h. 30m. p.m. The bulletin is issued between 2h. 45m. and 3h. p.m.

During bad weather the bulletin, which is then generally incomplete, is issued about 4h. p.m.

The report contains observations from 16 stations, 14 from this country, including Lisbon and Coimbra, and two from Spain.

The isobars are drawn on a small chart, together with small arrows, indicating the direction and force of wind.

The telegrams are all sent free.

The bulletins are supplied to all the Government offices and to public and private maritime offices and establishments frequented by the public.

When, after a study of the telegrams, it is found to be requisite, telegrams are sent to the semaphoric stations ordering the hoisting of storm-warning signals. The signals are a "cone" and "drum," the same as used in England,* with similar instructions.

The Central Office.

7. The following are the principal instruments of this observatory :—

Pressure :

2 Standard barometers, one of which is a siphon by Lerebours and Secretan, of Paris, 1854, tube 18·5 mm., and reading to 0·01 mm.

Standard cistern barometer, tube 32 mm., reading with cathetometer to $\frac{1}{20}$ mm.

Barograph on the photographic system, by Salleron, of Paris, 1863.

A Redier's barograph, 1878.

Temperature :

Standard thermometer, presented by the Kew Committee, 1853.

Thermograph, on the photographic system, by Salleron, of Paris, 1863.

A Redier's thermograph, 1880.

Direction and force of wind :

An Osler's anemometer modified, with Robinson's cups for direction, and a small Cator's anemometer for wind-force.

A portable anemometer, giving the direction and velocity, by Casella, 1879.

Instruments for daily readings :

Barometer by Adie, tube 10 mm.

Dry and wet bulb thermometers, Adie, 1857.

Do. do. do. Negretti and Zambra.

Actinometer, Marié-Davy and Negretti and Zambra.

Solar and terrestrial radiation thermometers, Negretti and Zambra.

Self-recording rain gauge, "udométre," by Babinet.

Self-recording rain gauge connected to the anemographe.

Evaporator, with diameter of 252 mm.

Ditto, by Piche.

Electrical thermometers on Becquerel's principle for depths of 10 metres and 5 metres.

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* The drum is not now used in England.

Thermometers on Lamont's system for depths of 1·5, 1·1, 0·7, 0·7, 0·3, and 0·05 metres.

Terrestial Magnetism.—Magnetometer, for the determination of the horizontal force and declination, by Elliott Brothers, on the metric system.

Dip circle, by Dover.

Magnetographs on the photographic system, by Adie, 1862.

Atmospheric Electricity.—Photographic electrograph, by Branly.

Thomson's portable electrometer.

The instruments of the two sections of the First Order, Sierra da Estrella and Loanda, are the following:—

Barometer, by Adie, metric scale.

Dry and wet bulb thermometers, by Negretti and Zambra.

Maximum and minimum thermometers, by „

Anemometer, by Casella, in kilometres.

Portable anemometer, by Casella.

Barograph, by Richard.

Thermograph „

Rain gauge, by Babinet.

Ordinary zinc evaporator and one by Piche.

Marié-Davy's actinometer (except at Loanda).

Solar and terrestrial radiation thermometers, by Negrettiand Zambra.

In addition to the above instruments, the station at Loanda possesses magnetical instruments for the determination of horizontal force (Johnson's magnetometer), declinometer by the same maker, and dip circle by Dover.

The instruments at the stations of the Second and Third Order, are the following:—

Barometer, by Adie.

Aneroid.

Dry and wet bulb thermometers, by Negretti and Zambra.

Maximum and minumum „ „

Anemometer, by Casella.

Self-recording rain gauge, Babinet.

Zinc evaporator, with diameter of 252 mm.

8. The station of Sierra da Estrella has two observers, one of whom has the superintendence; there is also a servant; total three employés: The staff.

	£
The salary of the superintendent is -	120
That of the second - - -	88
The servant - - - -	44
For the expense of the forage of a horse, for attendance, fire, lights, and incidental expenses - - - -	53

The other station of the First Order, Loanda, is under the superintendence of a naval officer, harbour-master, assisted by another officer, and sub-officers.

The salaries for these special services are borne by the Government of the province.

At the stations of the Second and Third Order the directors are professors, doctors, and engineers of public works; they receive no salaries.

The observers are paid 24*l.* a year.

At the four "international" stations, at which observations are made five times a day (including the simultaneous observation for Washington), there is a second assistant with a salary of 20*l.*

At Funchal, a special remuneration of 5*l* a year is added for the 7h. a.m. observation.

Publications.

9. The regular publications of this Institute are:

Annales do Observatorio do Infante D. Luiz, containing the various observations made at the observatory and those of the stations "*Postos meteorologicos*."

In addition there are the publications of the observations of terrestrial magnetism, and researches on various branches of meteorology.

There are no independent publications of the stations.

The Meteorological and Magnetical Observatory of Coimbra publishes meteorological and magnetical observations.

Management and inspection.

10. The management and inspection of the stations are carried out by this Central Institute.

The observers and subordinate employés are appointed by this observatory, on the nomination of the directors of the stations, subject to the approval of the Government.

The payment of the salaries of the observers and all attendant expenses of the system are fixed according to schedules of expenses approved by the Government from funds voted in the estimates of the Ministry of the Interior.

The inspection of the stations is done by the chief of the service of this observatory, although it is not done so regularly as might be desirable.

The instruments are supplied by this central observatory. There is a fixed sum provided in the estimates for the purchase of instruments.

Supplementary remarks.

11. The general vote for meteorology is at present the following:

Observatory of the Infante D. Luiz.

		£
Salaries	Director (honorarium) - -	88
	Observers (3) - - -	400
	Assistants (3) - - -	240
	Photographer - - -	32
	Servant - - - -	32
		£792

		£
Materials	Gas - - - -	53
		52
	Instruments - - -	109
	Chemicals - - -	25
	Printing (annals and bulletins) -	309
	Incidental expenses - -	53
		£601

Meteorological Stations.

	£
Sierra da Estrella - - -	308
Ten observers - - -	240
Four assistants - - -	84
	£632

Total expense - -	£2,025

12. The observatory of the Infante D. Luiz was established in 1854, but was only in 1863 installed in a building expressly erected at the Polytechnic School. Historical.

The station at Oporto was established in 1861, and two years later those of Guarda and Campo Maior.

In 1864 almost all the existing stations were established, and in 1865 Parliament voted in the estimates of the Ministry of the Interior funds for the outfit and maintenance of 10 stations.

The year 1865 may be quoted as the date of the regular foundation of the system, subordinate to this observatory as a central institute.

The two stations of the First Order are of more recent creation. The station of Loanda was only completed in October 1878. The station of Sierra da Estrella was established more recently; it has only been in operation since January 1882.

The Coimbra Observatory is not included in the system, but it was founded in 1864.

RUSSIA.

Dr. H. Wild, Central Physical Observatory, St. Petersburg.

1. The system of meteorological stations under the Central Observatory embraces the whole of the Russian Empire, except the Grand Duchy of Finland, which possesses a Central Observatory of its own at Helsingfors. The magnetical and meteorological observatory connected with the missionary establishment in Pekin is also under the Central Physical Observatory. Definition of system.

2. The following meteorological stations belong to this meteorological service :— Number and positions of stations.

(*a.*) Two stations of the First Order, viz. :—

Pawlowsk	-	Lat. 59° 41′,	long. 30° 29′,	height 133 feet.
Tiflis	-	„ 41° 43′,	„ 44° 47′,	„ 1343 „

at which complete hourly magnetical and meteorological observations are made (either direct or by help of self-registering instruments); and six stations, intermediate between those of the First and Second Order, viz., A, the magnetical and meteorological observations at Pekin, Catharinenburg, Barnaul, Moscow, and Nertschinsk, where, in addition to the ordinary observations made at stations of the Second Order, special observations (evaporation, earth temperature, radiation, &c.) and magnetical determinations at certain hours are made, and B, the observatory at St. Petersburg itself, where more extensive meteorological observations are taken.

(*b.*) 132 stations of the Second Order. The observations are taken three times a day, and include air-pressure, temperature, humidity, direction and force of wind, cloud, rainfall, and remarks; a number of these stations also make observations of earth temperature and evaporation.

(*c.*) 44 stations of the Third Order (viz., stations at which one or more of the elements mentioned for stations of the Second Order are not observed). In this category we have included the 17 lighthouse stations of the Baltic Sea, at which, for want of sufficient instruments, we have only been able to make use of the wind observations.

3. The complete meteorological stations generally possess the following instruments: a zinc screen, with dry and wet thermometer, hair-hygrometer, and minimum thermometer; a rain gauge and measuring glass, a Organization of stations.

small wind vane, with swinging plate for measuring the force, siphon barometer in metal frame, and an aneroid. The corrections of the instruments are determined at the Central Observatory, and the corrections are supplied to the observers. The hours of observation at stations of the Second and Third Order are generally 7h a.m., 1h., and 9h. p.m. At all the regular stations observations are made according to the "Instructions " for Meteorological Stations," by H. Wild (in the "*Repertorium für Meteorologie*," Vol. V., No. 1). The observations are reduced by M. Wild's "*Tafeln für Berechnung der meteorologischen Beobachtungen*," which are issued as a Supplement to the Instructions for meteorological stations.

The meteorological observations sent to the central observatory are generally checked by the staff of the observatory who attend to this work, by comparison with the data of synoptic charts, and with the observations of neighbouring stations, and the accuracy of the reductions is examined; finally, the means of the verified tables are extracted for publication. The Caucasian stations, under the superintendence of the Tiflis Observatory, send their observations to that observatory, and the latter, after they are checked, sends them to the central observatory ready for printing. The observations of the Caucasian stations, and those of the Pekin Observatory, are not subjected to any further check at the central observatory.

Special observations.

4. The stations at which only observations of rainfall, thunderstorms, and hail are made have been hitherto under the Geographical Society, but the number of such stations is small (about 40). Phenological observations are made at some places, but are not taken on any regular plan, and can therefore only be considered as casual observations.

Marine observations.

5. The Assistant of the Director of the Central Observatory, M. Rikatschew, has drawn up instructions for observations to be made by the Russian Navy in accordance with the decisions of the London Conference; these have only been introduced provisionally. The ships draw their instruments from the Hydrographic Department, to which they also send their logs; the Hydrographic Department transfers the logs to the maritime branch of the Central Observatory for examination and subsequent publication.

Weather telegraphy.

6. In the weather branch of the Central Observatory daily telegrams are received from 66 Russian (including 8 in Finland) and 54 foreign meteorological stations. These telegrams, which are composed of figures according to the International Code, mostly contain the observations of the previous evening, besides the morning observations of the day in question. After the telegrams have been converted, and the data reduced and entered in the registers, they are used in the ordinary way for the construction of synoptic charts. In addition to synoptic charts other charts are drawn showing the change in the weather from one day to another. Upon the basis of the data contained in these charts weather forecasts are prepared, and in the event of an impending storm the places affected are warned. At present regular storm warnings are restricted to the Ports of the Baltic, and some of the larger inland lakes (Onega, Ladoga, and Ilmen). A note is made of each storm warning, and the success is checked from the weather of the same and the following day.

The Central Office.

7. The Central Physical Observatory is a Government Institution under the Imperial Academy of Sciences, and like the latter belongs to the Ministry of Public Instruction. According to the various duties of the observatory, the following division of work is made among the different departments of the institution.

(*a.*) The Meteorological Observatory of St. Petersburg, in addition to the regular meteorological observations, undertakes the verification of instruments for the meteorological stations. One physicist and two observers are occupied in carrying out these duties.

(*b.*) The reduction, checking and printing of the observations from land stations are entrusted to a special department; this branch is directly under a physicist, aided by two computers.

(*c.*) The department for Ocean Meteorology consists of one physicist and two adjuncts. These have to undertake the reduction and checking of the observations made at maritime stations, lighthouses and on ships.

(*d.*) The weather department prepares the weather reports and synoptic charts and looks after the issue of storm-warnings. This work is done by a physicist and two adjuncts.

The Departments *c* and *d* are under the special supervision of the Assistant of the Director.

(*e.*) The mechanical workshop of the Observatory has to look after the construction of new and the repair of damaged instruments, and the furnishing and forwarding of instruments to the newly established meteorological stations. The mechanician of the Observatory carries out these duties with the help of one assistant.

In matters relating to administration the director has the assistance of a scientific secretary, and the necessary number of clerks; a steward is appointed for the superintendence of the buildings, including attendance to the Observatory.

Among the stock of the instruments of the observatory there are the necessary standard instruments for verifications; one or more self-registering instruments for each of the most important meteorological elements (air-pressure, temperature and humidity of the air, direction and force of wind and rainfall), as well as a gauge (Limnigraph) for registering the height of water in the Neva. In addition to the instruments for an ordinary station of the Second Order there are instruments in use for the determination of evaporation, of earth-temperature at various depths and of radiation.

The magnetical and meteorological observatory at Pawlowsk must be considered as a special department of the Central Institution under the superintendence of the director of the central observatory both as regards its administrative and scientific relations. The immediate supervision of the work in this observatory is deputed to a manager, with the assistance of a physicist and three observers. In addition a mechanician and a steward are attached to the Observatory.

This observatory possesses a complete series of self-registering meteorological apparatus, viz., barograph (Hasler), thermograph (Hasler), anemograph (Munro and Schulze), rain-gauge and evaporator (Hasler), and sunshine recorder (Campbell). Besides the instruments necessary for a station of the Second Order (erected in various ways), there is also apparatus for determining evaporation in the shade and from an open surface of water, earth-temperature at various depths, &c.

For magnetic observations the observatory is furnished (in addition to the apparatus for absolute determinations of the elements of terrestrial magnetism) with magnetometers (unifilar and bifilar magnetometers and a Lloyd's balance) and magnetometers for direct measurements of variation. The Observatory also possesses instruments for the determination of the intensity of earth currents and an electrometer for observations of atmospheric electricity.

The Physical Observatory at Tiflis, with the dependent meteorological stations of the Caucasus, is, as regards its scientific relations, under the

superintendence of the Central Institution, and is dependent, administratively, upon the Government of the Caucasus. The director is nominated by the Academy of Sciences, upon the proposal of the director of the Central Observatory and is appointed by the governor of the Caucasus. In addition to the instruments required for the usual meteorological observations at a station of the Second Order the observatory possesses instruments for determining earth temperature at various depths, evaporation, radiation, &c. It has also the following self-recording instruments, barograph, thermograph, and anemograph by Hasler. For magnetic measurements, an altazimuth by Repsold and dip circles by Girgensohn and Dover are used; for observations of magnetic variation a unifilar magnetometer, a bifilar magnetometer and a Lloyd's balance are used.

The observatories at Catharinenburg, Barnaul, Nertschinsk, Bogoslowsk, Blagodat, Lugan, and Slatoust are managed by the Department of Mines and are only subordinate in their scientific relations to the Central Observatory. The three first-named observatories possess, in addition to the instruments for the usual meteorological observations, apparatus for magnetic measurements. In some districts there are central administrations for the more remote stations. For instance, the meteorological stations in Turkestan are superintended by the Observatory at Taschkend, those on the Black Sea by the Hydrographic section at Nicolaieff, and those on the coast of the Pacific Ocean by the Hydrographic section at Wladiwostok. The observations of these stations are sent to the Central Observatory, like those which belong directly to it, for examination and publication.

he staff, &c.

8. The following shows the distribution of offices charged to the vote of the Central Physical Observatory and of the filial institution at Pawlowsk :—

Central Observatory :—

	Salary. £
Director (in addition to his salary as Academician and a personal allowance)	270
Assistant to director	204
Scientific secretary	180
Two physicists (each)	180
Two junior observers (each)	120
Two computers (each)	60
Steward	75
Mechanician	67

Department for Storm Warnings and Ocean Meteorology—

Assistant of the director for the management of the department	204
Two physicists (each)	180
Two adjuncts (each)	120
One computer	60
Two draughtsmen (each)	72
One lithographer	54

In addition to these permanent officials there is the necessary number of computers, writers, and servants paid by wages, provided from special funds.

Memorandum.—The director, the secretary, and the steward have apartments in the Observatory.

Pawlowsk Observatory:—

	Salary. £
Superintendent - - - - -	360
One physicist - - - - -	240
Three junior observers (each) - - -	150
One mechanician - - - - -	150

The assistant of the mechanician and the servants are paid from special funds.

MEMORANDUM.—All the officials of the Pawlowsk Observatory have apartments provided.

The observers at the meteorological stations of the Second Order are generally volunteers, and receive no remuneration, excepting at the coast stations, those in Turkestan, and partly those in the Caucasus, where the observers are paid by the local Administrations.

Publications.

9. The observations from the observatories and from the meteorological stations in Russia are published in the Annals of the Central Observatory. The following volumes have hitherto appeared:—

"*Annales de l'Observatoire Physique Central*, 1848–1869," (in continuation of the "*Annuaire magnétique et météorologique*, 1835–1847," issued by the Administration of Mines).

"*Annalen des physicalischen Central-Observatoriums*, 1870–1881."

In the years 1850–1864 results of the observations and other communications were published in the "*Correspondances Météorologiques*."

The weather telegrams are all received free, and are published daily in the Bulletin, which has appeared since the year 1872. The Supplement to this bulletin contains papers on the mean tracks of the barometric minima and maxima, on the determination of the probable direction of the translation of depressions, and on remarkable phenomena of weather.

Discussions by the staff of the Observatory relating to meteorological and magnetical phenomena in Russia are published under the superintendence of the Director, Professor H. Wild, in the *Repertorium für Meteorologie* of the Academy of Sciences. Seven volumes and a supplement of this work have appeared.

Detailed information as to the position and the development of the operations of the Central Observatory and its subordinate institutions are given in the yearly Reports of the director. The volumes for the years 1859–64 have appeared under the title *Compte-rendu du Directeur* and from the year 1869 the *Jahresberichte* have been published, and in recent years have been printed in the *Repertorium für Meteorologie*.

The Tiflis Observatory publishes its observations *in extenso* and other meteorological data in the *Materialen zu einer Klimatologie des Kaukasus*.

Since the year 1880, when hourly observations were recommenced at this observatory these observations have been printed *in extenso* in *Meteorologische Beobachtungen des Tifliser physikalischen Observatoriums*," and in addition the observations of earth temperature are published separately. This observatory has also published since the year 1879 the "*Magnetischen Beobachtungen des Tifliser physikalischen Observatoriums*." Of the other observatories *Dorpat* only publishes its observations, made at all the odd hours, under the title "*Meteorologische Beobachtungen in Dorpat*."

Management and inspections.

10. The stations are inspected as far as posssible by the staff of the Central Physical Observatory. As however a long absence of these officials is inconsistent with the regular performance of their duties, the more remote stations of the empire can only be inspected very seldom.

The stations in the Caucasus are from time to time inspected by the director of the Tiflis Observatory or by officials deputed by him.

Some attempts have also been made at inspecting their respective subordinate stations by the observatory in Taschkend, the Hydrographical Departments in Wladiwostok and Nicolaieff, but these have not been altogether successful, owing to the want of suitable persons.

Details as to the management of the stations have already been given under point 7.

upplentary marks.

11. For the maintenance of the meteorological institutions in Russia the Government expends the following amounts :

	£
1. Central Physical Observatory, with its various departments	6,723*
2. Magnetical and Meteorological Observatory at Pawlowsk	2,378
3. Physical Observatory at Tiflis	1,749
4. Magnetical and Meteorological Observatory at Peking	786
5. Maintenance of the Mine Observatories	1,080
6. „ Meteorological stations	600

The cost of maintenance of the Taschkend Observatory, with its subordinate stations in Turkestan, and the expenditure of the Ministry of Marine for meteorological purposes, are not accurately known.

istorical.

12. The first meteorological observations in Russia were made by the Academy of Sciences at St. Petersburg ; these were begun in 1726. Then follow, in the second half of the last century, the following places, from which useful observations exist : Astrachan, Abo, Isolikanisk, Pischminsk, Ochotsk, Moscow, Warsaw, and Riga.

It was only in the present century that meteorological observations in Russia received a considerable impulse, when measures were taken for the establishment of meteorological stations by the Ministries of Marine and Instruction. We are indebted to the first for the establishment of stations at many ports, like Nicolaieff and Cherson, while the latter, on the proposal of the Wilna University, made in the year 1803 a regulation for meteorological observations, to be taken at all schools of the Wilna educational district. This regulation was extended in the year 1832 to other schools in the Empire, for in this year the Ministry of Instruction, at the instance of the Academy of Sciences, addressed a circular to the Universities and the upper and middle class schools, requesting that meteorological observations should be made in accordance with the instructions of the Academy. From this time meteorological observations quickly increased. The efforts of the Hydrographic Department of the Navy in establishing stations on all the coasts of the Empire, on the one hand, and on the other the very great sacrifices which the Mine Department of the Finance Ministry made in founding the magnetical and meteorological observatories at St. Petersburg, Catharinenburg, Barnaul, and Nertschinsk, and the meteorological observatories at Bogoslowsk, Slatoust, and Lugan, deserve especial mention. This not only gave the impulse for the establishment of similar observatories by other authorities in Moscow, Kasan, Tiflis, Pekin, and Sitka, but also led the Department of Mines in 1849 to establish the Central Physical Observatory, as an indispensable centre for the continuous superintendence of the observatories and the stations as well as the collection and publication of their observations. The Central

* In this sum are included the expenses of the various operations of the Central Observatory, which cannot be reckoned as properly belonging to a Central Institution or Meteorology and Terrestrial Magnetism.

Physical Observatory soon became the depository of most of the meteorological observations in Russia. The endowment of this institution, which was absolutely insufficient both as regards staff and funds, soon led to the exhaustion of its existing power and to the rapid decrease of the superintending activity of the institution. The result of this was that the number of meteorological stations had considerably decreased about the beginning of the year 1860. A reorganisation of the meteorological service in Russia, which was begun both by the Ministries of Instruction and Marine in the year 1864, had no permanent result, because the Central Institution itself was not first reorganised. It was only since the year 1865, at the time when the Academy of Sciences (to which the Central Physical Observatory was then transferred) effected the reorganisation of the meteorological system, and especially of the Central Observatory, we see the number of stations in Russia and the quality of the observations entering a phase of rapid and constantly increasing development.

RUSSIA.—FINLAND.

Professor A. K. Nordenskiold, Central Meteorological Institute of the Society of Science of Finland.

Definition of the system.

(1.) The following particulars refer to the meteorological service of the Grand Duchy of Finland.

Number and position of stations.

(2.) In Finland there is really only one station of the First Order, that of Helsingfors. But, for the year of polar exploration, three temporary stations have been added; the meteorological and magnetical station of Södankylâ, in the polar regions, and the meteorological stations at Wasa and Wârtsilâ.

Helsingfors:	Lat.	60°	10′	22″	8	Long.	24°	57′	3″	8 Greenwich
Sodankylâ:	Lat.	67	25	—	—	Long.	26	36	—	—
Wasa:	Lat.	63	5	—	—	Long.	21	33	—	—
Wârtsilâ:	Lat.	62	10	—	—	Long.	30	38	—	—

Ten stations may be regarded as being of the Second Order, of which, however, at present the majority do not take hygrometric observations.

Twenty-five stations may be regarded as Stations of the Third Order, although they have been nearly all provided with very accurate mercurial barometers.

Organization of stations.

(3.) For want of self-registering instruments the observations are made by young male or female observers. At the stations of the First Order meteorological observations are made every hour, day and night, and at nearly all the Stations of the Second and Third Order they are made at 7h. a.m., and at 2h. and 9h. p.m.

The Instructions are for the greater part in writing, and the observations (except those of Sodankylâ) are sent monthly to the Centra. Institute of Helsingfors, where the barometric and thermometric observations are checked by curves drawn graphically.

Special observations.

(4.) There are no special stations for observations of thunderstorms and hail. Since the year 1845 the Finland Society of Science has annually distributed special registers, all of the same form, for phenological observations. In 1882 such registers were returned from 57 stations.

Marine observations.

(5.) Maritime observations, strictly speaking, are not made here. At eight Pilot stations, which form a special class of stations, observa-

tions are made of the height of the water, as well as of the direction and force of wind.

Ordinary meteorological observations are made at nearly all the light-houses of the Gulf of Finland and of the Baltic Sea.

Weather telegraphy.

(6.) The Central Meteorological Institute of Helsingfors receives daily meteorological telegrams from eight stations in Finland.

The meteorological telegrams sent from Norway and Sweden to St. Petersburg are copied on their way at Helsingfors; and a telegram from St. Petersburg giving the atmospheric condition of several places n Russia is received daily.

All these meteorological telegrams, when reduced at the Central Institute, are published in five daily newspapers at Helsingfors. As long as the navigation is open, the ports of Helsingfors and Hanga receive by telegraph storm warnings from the Central Physical Observatory of St. Petersburg.

The meteorological telegrams from the provincial stations are sent not only to Helsingfors, but also to St. Petersburg.

The Central Office.

(7.) In accordance with the decree of His Majesty the Emperor-grand-Duke of the 27th October 1881, the Magnetical and Meteorological Observatory of Helsingfors was reconstituted as the Central Meteorological Institute for Finland, while continuing to belonging to the Society of Science of that country. The temporary station of Sodankylâ, which is also subordinate to the same society, is independent of the Central Institute of Helsingfors.

For the purpose of buying new instruments, the Central Institute received, according to the same decree, a lump sum of 656*l.*; but from unforeseen circumstances the instruments have not yet been bought.

The staff.

(8.) The Director is the only regular officer of the Institute. His salary is 325*l.*, with an increase of 32*l.* 10*s.* after five years, and another 32*l.* 10*s.* ten years later, with apartments situated in the court of the Institute.

The Institute receives annually 800*l.* from the public funds for observations, and the maintenance of buildings, and furniture, attendance, lighting and other expense.

The computers and the observers at Helsingfors have 6*d.* an hour. The night observers have only 5*d.* an hour, but they are lodged free in the Institute. Only those provincial observers who forward daily meteorological despatches to the Institute receive remuneration.

At Hango the remuneration of the observer is 20*l.* per year, the other observers receive only 7*l.* 10*s.*

The observers at Wasa and Wârtsilâ are either paid from private sources, or they are persons interested in the science, and observe voluntarily.

Publications.

(9.) Besides the publication of the meteorological telegrams the Central Meteorological Institute publishes the "Månadsöfversigt of Vâderleksförhâllander of Finland," and the "Årsbok."

As far as possible it will also publish some of the valuable observations of earlier date.

This, however, could not be done in the year 1882, for owing to the small means at the disposal of the Institute it has had to concentrate its efforts in supplying the observatory at Helsingfors with new magnetical

instruments, and in establishing the meteorological stations at Wasa and Wârtsilâ.

In the "*Ôfversigt of Finska Vetenskaps-Societetens Fôrhandlingar*," the Counsellor of State Moberg has for several years published a summary of phenological observations made in Finland, as well as those made on the height of the water near the pilot stations.

Management and inspections.

(10.) All the business of the Institute, the decision of which does not belong to the director only, must be submitted to a meteorological delegation named by the Society of Sciences of Finland. The more important questions are submitted with reports of the same delegation to the Society of Science.

The audit of accounts and other property of the Central Meteorological Institute is made annually in March by the meteorological delegation.

In the same month the director has to submit to the Society of Sciences the annual report of the Institute.

The Society of Sciences has the right to send either the director or any other competent person to inspect the stations in the provinces, and to charge the expenses to the public funds.

Historical.

(12.) The Economical Society of Finland, founded in 1798, has made meteorological and climatological observations at several places in Finland from the beginning of this century.

A part of these observations has been carefully treated in several works by Professor Hållstrom. Since the year 1840 a number of medical men, both in town and country, have been requested by the Central Council of the sanitary establishments to make meteorological observations, and they have worked zealously.

At the meeting of 2nd June 1845, Herr von Hartmann, chief of the above council, proposed to transfer the direction of meteorological matters to the Society of Science in Finland. This proposal was accepted, and the society determined to send accurate barometers and thermometers to various places in the following winter.

Since that time the Society of Science has continued to collect observations on the climatology of the country. The Society has had the meteorological stations inspected three times; in 1848, 1858, and 1871, Great progress has been made in the meteorological science of Finland by the establishment of the Magnetical and Meteorological Observatory at Helsingfors; for, up to the death, in 1848, of its founder, Professor Nervander, this establishment had done all that could be expected at that time, from such an institute.

From June 1844 until the middle of the year 1857 observations were taken every twenty minutes, day and night, and after that time once an hour.

The Observatory was established out of the funds of the University, and was constituted an integral part of it.

By a decree from His Majesty the Emperor Grand Duke this observatory was transferred on the 1st of July 1880 from the University to the Society of Sciences, and, as before stated, it was reorganised, in the year 1882, as the central establishment for the meteorological service in Finland.

SWEDEN.

A.—*Dr. R. Rubenson, Central Meteorological Institute, Stockholm.*

Definition of system.

1°. The principal duties of the Swedish Central Meteorological Institute may be comprised under the two following general heads :—

(1.) *Climatological Investigation of the Country.*—Management of the system of observations, including both official and private stations (*see below*), together with yearly publications of the observations of these stations and the utilization of the results.

(2.) *Weather Investigations.*—Telegraphic weather correspondence. Publication of the Daily Reports, and forecasts of weather.

Number and positions of stations.

2°. There is only one Station of the First Order in Sweden, viz., the Meteorological Observatory at Upsala, an establishment which is independent of the Central Office. It publishes an independent volume under the title of "*Bulletin mensuel de l'Observatoire Météorologique de l'Université d'Upsal.*"

The following systems of observations are dependent upon the Central Meteorological Institute.

The Stations of the Second Order are partly official, 33 in number, and partly private, 21 in number; 14 of the latter have been fitted up by the Economical Society. To these may be added the forest stations, which are provided for by the forest administration (*see* § 4).

321 stations may be considered as Stations of the Third Order, at which only observations of precipitation and partially of air temperature are taken. These stations are for the most part fitted out with instruments at the cost of the Economical Societies of the different Government districts.

With regard to the Stations of the Fourth Order, at which special observations are made without any instruments (*see* Section 4).

Organization of stations.

3°. With respect to the outfit of the Meteorological Observatory at Upsala, a special report has been communicated to the International Meteorological Committee by its director, M. Hildebrandsson.

The Stations of Second Order are supplied with the following instruments :—

1. Siphon barometer.
2. Two thermometers (Psychrometer) by Åderman.
3. Rain-gauge, with two measuring glasses.
4. Some stations have wind-vanes.
5. All stations have maximum and minimum thermometers.

The hours of observation are generally 8h. a.m., 2h. and 9h. p.m.

The following instructions have been issued to the observers :—

1. Edlund, E., "*Handledning vid meteorologiska observationers* anställande för de af K. Vetenskaps—Akademien för detta ändamål antagna observatörer." Stockholm, 1858, 8°.
   Do. Second edition, by H. E. Hamberg. Stockholm, 1882, 8°.
2. "*Om psychrometerns skötsel.*"
3. "*Kort instruktion för anställande af meteorologiska observationer.*"
4. "*Instruktion för observation af maximi—och minimi thermometrar.*"
5. "*Instruktion för mätning af nederbörden.*"

For the reduction of the observations, Guyot's tables are generally used, and for hygrometric observations Jelinek's Humidity Tables.

The checking of the observations is effected partly by inter-comparison of the registers of different stations and partly by inspections.

4°. The Forest stations, the expense of which is borne by the Forest Administration (now the Administration of Domains) have been established under the direction of the Central Meteorological Institute, and are under its management. Two of these (Forest and Field stations) are in the district of Skaraborg, three in Vestmanland, and one (a Forest station) in Upland. To this system also belongs a tidal station at the mouth of the Clara, and some rain stations. Special systems of observations, Stations of the Fourth Order, exist also for the following phenomena :— Special observations.

(1.) Thunderstorms and hail, 97 stations.
(2.) Freezing and breaking-up of the ice in the lakes, 79 stations.
(3.) Phenological phenomena, 108 stations.

5°. Maritime observations are under the direction of a special institution, the Nautical Meteorological Office at Stockholm, the duties and organization of which are stated in a special report to the International Meteorological Committee by the Director of that office, Captain F. Malmberg. Marine observations.

6°. The Central Meteorological Office receives weather telegrams daily from 9 inland and 21 foreign stations, made at 8 a.m., and the previous evening, and from 3 Swedish and 2 foreign stations, at 2h. p.m., viz. :— Weather telegraphy.

Morning Telegrams from—

Haparanda.	Borkum.
Hernösand.	Hamburg.
Falun.	Swinemünde.
Upsala.	Neu-Fahrwasser.
Stockholm.	Krefeld.
Carlstad.	Leipzig.
Gothenburg.	Breslau.
Wisby.	Archangel.
Karlshamn.	Hangö.
Bodö.	St. Petersburg.
Christiansund.	Riga.
Skudesnæs.	Dunrossness.
Oxö (Christiansand).	Aberdeen.
Copenhagen.	Yarmouth.
Fanö.	Valencia.

Afternoon Telegrams from—

Haparanda.	Stockholm.
Gothenburg.	Skudesnæs.
Aberdeen.	

Also a morning telegram from France, containing 8h. a.m. observations. This collective telegram, however, generally arrives too late to be of immediate use.

With this material, a synoptic chart is constructed daily between 12 and 1 o'clock. and a summary of the weather over Northern Europe is prepared, with probabilities of impending weather. A report of the morning telegrams is made available without delay for the general public, (1) by posting it up at several places in the capital, (2) by communicating it to the Stockholm daily papers, one of which, the "Aftonbladet," is supplied with a synoptic chart, and (3) by sending a concise summary, accompanied with the forecasts, to the Railway Administration, which communicates them by telegraph to its principal

stations in order to make them available to the general public by exhibition there.

The daily weather reports from Sweden, together with those from Norway and Denmark, are published fortnightly in the "*Bulletin du Nord.*"

The Central Office.

7°. The Central Meteorological Institute is under the supervision of the Royal Academy of Sciences, but is more directly under the superintendence of two of its members, who are appointed as Visitors. The institution has two permanent officers, viz., a professor and a secretary, who are appointed by the Academy, on the nomination of its Physical Class. The Institution possesses no special meteorological observatory. It is situated in the buildings of the Academy. All expenses are met out of the Government funds.

The staff.

8°. The professor receives a yearly salary of 220*l.*, with 55*l.* so-called "service money," and two increments of 27*l.* 10*s.* each after five and ten years' service.

The secretary receives 137*l.* 10*s.* a year.

There is also a servant (who acts as telegraphist) attached to the Institution at a salary of 38*l.* 10*s.* (Since January 1, 1883, the salary has been 55*l.*)

The computations are carried out by supernumerary assistants. In the year 1882 these were seven in number.

The observers at the official stations receive a remuneration of 11*l.* a year.

Publications.

9°. The observations of the stations of the Second Order are published up to the present time by the Royal Academy of Sciences in the annual volume "*Meteorologiska Jakttagelser i Sverige*," under the superintendence of the Central Meteorological Office. Volumes 1–6 (1873–8) of the second series of this work have appeared. These form parts 15–20 of the whole work.

The results of rainfall and temperature for many years have been published in several papers in the "*K. Sv. Vet. Akad. Handlingar*," vols. 12–14.

The rainfall observations at all the stations of the country, both public and private, are published by the secretary, Dr. E. Hamberg, in a monthly periodical, entitled "*Månadsöfversigt af väderleken i Sverige.*" This publication is under the supervision of the Central Meteorological Office.

Management and inspections.

10°. Each year some official stations, and generally some private stations, or forest stations, also are inspected.

Historical.

12°. The Swedish system of meteorological observations was established by Professor Edlund in the year 1858, and transferred to the Central Meteorological Institution upon its foundation on the 1st January 1873. Since that time, besides a considerable increase of official stations, all the private stations of the Second and Third Orders, forest and rain stations, have been started. The system of special observations of the state of the ice, thunderstorms, and phenological phenomena, was transferred in the year 1881 to the Central Meteorological Office from the Meteorological Observatory at Upsala.

B.—*Captain F. Malmberg, Nautical Meteorological Office, Stockholm.*

1°. The Nautical Meteorological Office, which was organised in the year 1878, and commenced operations in the year 1879, collects and utilizes all the meteorological observations which are made on board Swedish ships, both of those which make long voyages and also those which navigate the Baltic, the Cattegat, and the North Sea. It superintends and discusses the meteorological and physical observations which are made at Swedish lighthouses and lightships; it also renders service to navigation by purchasing and supplying other instruments besides those for meteorological purposes to seamen, so far as funds are at its disposal, and by purchasing and rendering available books and charts which are of importance from a nautical and meteorological point of view, and which are not in the collection of the Hydrographic Office. It also prepares meteorological reports and other information for seamen, from the results to be derived from meteorological and scientific treatises. Definition of system.

2°. There are 19 meteorological stations of the Third Order belonging to the Institution, and 19 rainfall stations, all of which are situated at the lighthouses of the kingdom. Number and positions of stations.

3°. The meteorological stations are all provided with barometers, thermometers, Hagemann's hand wind-gauges and with rain-gauges. Two of the stations, Bremö and Kungsholmen, have also maximum and minimum thermometers. Organization of stations.

With respect to the form and exposure of the instruments, plans will be found in the "Instructions for meteorological observations taken at Swedish lighthouse stations" (No. 4). The hours of observations are the same as those at the official stations of the Central Office, viz., 8 a.m. 2 and 7 p.m.

5°. Meteorological observations, in complete accordance with those prescribed in the English meteorological log, are now made on board 25 merchant ships, and in those ships of the Royal Navy which visit distant seas, and after extracts have been made from the logs of all that is of interest to the institution, the logs are sent to the meteorological institute at Utrecht, in order to be utilized there in connexion with other similar observations, as the observations are not sufficient for independent discussion. Marine observations.

The instruments necessary for the above-mentioned merchant ships are lent without charge by the office. There are also 15 hydrographical observing stations connected with the Office, 8 of which are on board lightships, and 7 are land stations.

At the lightships and at two of the shore stations daily observations are made at 8 a.m. of the direction and force of wind, temperature of the sea and its specific gravity, both at the surface and at three different depths fixed for each station, together with the direction and rate of the current. At the five other stations the observations are restricted to the temperature and specific gravity of the sea surface and the direction of the current. For the instruments used at these stations we refer to the "Instructions for hydrographic observations made at Swedish light and pilotboat stations (No. 5)."

8°. With the exception of the Director of the Office, who is paid by the Government, there is no one permanently attached to it, but temporary assistants are engaged when necessary. The observers, who are light-keepers, receive no pay from the Office, excepting those who take The staff.

hydrographic observations at the land stations, but all these observers, as well as the captains of ships who keep meteorological logs for the Office, receive a copy of M. Rubenson's "Handbok i Nautisk Meteorologie."

Publications.

9°. The following instructions have been published by the Office :—

(*a.*) "Instruktion for meteorologisk logboks förande" (No. 1).
(*b.*) "Meteorologisk anteckningsbok" (No. 2).
(*c.*) "Väderleksbok" (No. 3).
(*d.*) "Instruktion for meteorologiska observationers utförande vid "Svenska fyrstationer" (No. 4).
(*e.*) "Instruktion for hydrografiska observationers utförande vid "Svenska fyr och lotsstationer" (No. 5).
(*f.*) "Hydrografisk observations Journal" (No. 6).
(*g.*) "Instruktion for Nederbörds mätnings-observationers utförande vid Svenska fyrstationer" (No. 7).*

Management and inspections.

10°. The Office is under the superintendence of the Admiralty, and the business of the office is managed by a Superintending Committee, composed of the chief of the Hydrographic Office, the Director of the Central Meteorological Office, and the Director of the Nautical Meteorological Office.

The Director of the Office undertakes yearly tours of inspection, and during his absence his duties are performed by the Chief of the Hydrographic Department, in whose establishment the Nautical Meteorological Office is located.

C.—*Dr. H. Hildebrandsson, Observatory, Upsala.*

Meteorological observations have been made at the Astronomical Observatory at Upsala two or three times a day from the beginning of the last century. The first manuscript, which is still here, is for the year 1722, but bears the number 9. At that time Erick Burman was Professor of Astronomy. The oldest manuscripts are in his handwriting. These oldest observations were published in extract in the *Acta Litteraria*. The *Acta Litteraria* were the earliest publications of the Royal Society of Sciences at Upsala. Burman and his coadjutor and successor, the renowned Anders Celsius, organised a regular system of observations, embracing many stations in Sweden. The registers were sent to Upsala and many of them are still preserved in the Meteorological Observatory. Most of them, however, appear to have been lost. The Upsala registers have been continued with few exceptions until the present day. The registers of the first 10 years, and after a gap between 1732–38 inclusive, the following ten-yearly periods, have been kept very well according to the conditions followed at that time, by Hiorter, the adjunct and fellow-worker of Celsius.

Towards the close of the last and the beginning of the present century the observations were made very badly. M. Gustave Svanberg first introduced good order in the beginning of the decade of 1830-40, and since that date the registers are trustworthy. He published the observations for 1855–62 *in extenso* in the *Résultats des observations météorologiques*

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* A copy of each of these accompanied this letter.

faites au nouvel observatoire d'Upsal. The new observatory, outside the town, was opened in 1853. The observations in the "Résultats" are generally good, but the exposure of the wind-vane at that time left much to be desired.

In the year 1864 a department for meteorology was organised at the observatory. At first, however the work was done entirely by volunteers. Dr. R. Rubenson, now Director of the Central Office in Stockholm, P. G. Rosén, now Professor and Chief of the Geodetical Surveys in the Royal Staff Corps, and the undersigned formed a society for meteorological observations among the students. A little stone building was erected and the observers were carefully trained by us. On the 30th May 1865 hourly observations were begun under Rubenson's superintendence. The observers were told off for continuous hours, and observed day and night every hour until the 9th August 1868. *Not a single observation was lost*, and the series obtained is without doubt one of the most complete and most trustworthy that exists. The work was quite voluntary and gratuitous, and the publication of the results was made by free contributions of many persons under the title "*Observations météorologiques horaires exécutées par une société d'étudiants, á l'observatoire de l'Université d'Upsal, dirigés et publiés par R. Rubenson.*"

In the year 1868 Svanberg had brought matters so far that the first meteorograph was purchased and erected in the above-mentioned house. It was one of Theorell's older construction, described in *Theorell's "Description d'un météorographe enregistreur construit pour l'Observatoire d'Upsal. Nova Acta Soc. Reg. Scient. Ups.,"* vol. vii. No. 11; also in the "*Zeitschrift d. öster: Gesellschaft für Meteor.,*" vol. iv. p. 497. A self-registering wind-vane had been previously erected there. At the same time Svanberg succeeded after strenuous exertions in carrying on his meteorological department at least as an extra department of the University. Rubenson was appointed adjunct and chief of the meteorological department of the University by the Chancellor of the University, and received a salary of about 220*l.* In addition, two assistants were engaged, and paid about 38*l.* The observations from December 1869 have been published in the "*Bulletin Mensuel,*" and the cost of this publication is divided between the University and the Royal Society of Sciences. All other publications are provided for by the Observatory. The undersigned was sent abroad in 1869 in order to study modern meteorological work. His report is published in the "Årskrift" of the University. In 1871 he succeeded, with the co-operation of the Royal Agricultural Society, in organising in each Government of Sweden a system of observations at about 300 Stations. These stations observed thunderstorms, night-frosts, ice-conditions of the lakes, rivers, and streams. The registers were forwarded to the Observatory at stated times, and the discussion was carried on there by himself gratuitously. The observations were increased in 1873 by phenological observations and at some stations by cirrus observations.

When Dr. Rubenson was appointed Director of the new Central Office in Stockholm in 1872, I undertook, as his successor, the management of the Meteorological Department of the Observatory at Upsala. In 1873 a Robinson's anemograph was erected, and in the following year I obtained the necessary funds for procuring and setting up a Theorell's printing meteorograph. See "*Theorell: Description d'un Météorographe imprimeur construit aux frais du Gouvernement, K. Vet. Akad., s.j. Stockholm.*" *Handlingar*, Bd. 10, 1871. The

two assistants were then discharged, and in their stead a permanent assistant was appointed, with a salary of 55*l.*

In 1878, after Professor Svanberg had resigned, the Diet, on the proposal of the Government, voted the funds for the separation of the Observatory, and consequently an independent Meteorological Observatory was established.

The staff consists of two persons only, the Director, with salary as Professor at the University; one assistant, with a salary of 55*l.* In addition, we received for all other expenses 165*l.*, and in 1882, 280*l.* This amount includes the expenses of computers and the publication of the "*Bulletin Mensuel.*" On the other hand, we have from the University fire and attendance, and free postage is specially granted by the Government, for all communications to and from the Observatory.

We are in telegraphic communication with the Central Office in Stockholm, but being an institution of the University we are independent of that office. The above-named Stations of the Third Order which I established in 1871 and superintended for 11 years, were, upon my proposal taken over by the Central Office. Only the cirrus observations are now sent here.

Our means are consequently very limited. Happily volunteers are never wanting among the older students, so we do not suffer from want of working power. Our greatest want is a building of our own, and I have the hope that we shall get this in the immediate future.

The position of the Meteorological Observatory at Upsala in 1882 is as follows:—

Staff.—Director, with salary as Professor at the University

Assistant, with salary, 55*l.*

Two computers paid by piecework.

Expenses, 280*l.*

Official Publication, Bulletin mensuel de l'Observatoire Météorologique de l'Université Royale d'Upsal.

Meteorographs.—(1.) Theorell's first meteorograph, for barometer and dry and wet thermometers, has been in operation since 1868.

(2.) Theorell's printing meteorograph, since 1874.

(3.) A mechanically registering wind vane, since 1866.

(4.) A Robinson's anemograph.

(5.) A self-recording rain-gauge, under construction.

SWITZERLAND.

Dr. R. Billwiller, Swiss Central Meteorological Office, Zürich.

Definition of system.

1. The present meteorological service in Switzerland is mostly composed of volunteer stations. Meteorological observations are only made officially at the cantonal observatories of Geneva, Berne, Neuchatel and Basle, as well as at the Federal Observatory at Zürich. The object is to determine the climatic conditions of the country. The results of the observations are discussed scientifically by the Central Office (*see* No. 7), and in doing this particular attention is paid to local peculiarities of climate in their relation to their elevation of the land.

Number and positions of stations.

2. Berne is the only Station of the First Order, according to the definition of the Congress—

Lat. 46° 57′ N., Long. 7° 26′ E. Height, 1,880 feet.

There are 75 Stations of the Second Order, including Geneva, St. Bernard, and Säntis. At Geneva and St. Bernard observations are

made every two hours from 6h. a.m. till 10h. p.m. At Säntis direct observations are taken at 7h. and 10h. a.m., 1, 4, and 9 p.m., and pressure is recorded hourly by a Höttinger's barograph. In the coming summer an anemograph by Munro will be erected, and the station will be raised to the rank of the First Order, by further additions to its outfit.

Organization of stations.

3. The station of the First Order, at Berne, possesses two sets of electrically registering instruments by Hasler of Berne, for temperature, pressure, relative humidity, wind-direction, and force and rainfall.

The stations of the Second Order are supplied with cistern barometers, dry and wet bulb thermometers (some stations use Höttinger's percentage hair hygrometer instead of the wet bulb thermometer), wind vanes with Wild's pressure-plate, and rain-gauges.

The stations of the Third Order all observe at least temperature and rainfall, and keep a record of the state of the weather. There is also now a system of rainfall stations distributed over the whole country, which we include in a special category. At the end of 1882 there were 165 of these stations at work in the cantons of Zürich, Thurgau, Schaffhausen, Zug, St. Gall, Appenzell, Aargau, Basle, Lucerne, Freiburg, Schwytz, and Waadt. The hours of observation are 7h. a.m., 1h. and 9h. p m., except at Geneva and St. Bernard; and 7h. a.m. at the rainfall stations.

The instructions in use are those issued by the former Meteorological Commission of the Swiss Naturalist's Society :—"*Instructionen für die Beobachter der meteorol. Stationen der Schweiz. Zürich*, 1863." The changes which have become necessary by the decisions of the Congress have been communicated to the observers by special circulars.

The tables used for the barometer are Kämtz's, with the suppression of one decimal figure; and for the hygrometer, Regnault's tables.

The observations are checked at the Central Office, and the partly uncorrected and partly reduced observations are critically examined and the errors corrected by the help of the observations from neighbouring stations.

Special observations.

4. Thunderstorms and hail will be observed from the year 1883 at a great number of special stations. For this purpose the rainfall stations will above all be turned to account. Special instructions are supplied to the forest officials for the observation of hail.

Weather telegraphy.

6°. 73 Stations send observations to the Central Office at Zürich by telegraph twice a-day. Some of the telegrams contain the observations of the previous evening, and of the early morning; some contain the last-mentioned observations and those of 1h. p.m., and others those at all three hours. A collective telegram containing evening and morning observations from five stations is sent about 10h. a.m. to Vienna and Rome, and another containing the morning and midday observations from two high level stations is sent to Hamburg about 2h. p.m.

The Swiss Central Office receives from the three central offices just mentioned collective telegrams containing the morning observations from a number of stations from their own neighbouring systems. The Central Meteorological Office in Paris receives the observations from Berne only, and sends its despatch, drawn up for the Agricultural Service, with the summary of pressure, to Switzerland.

Upon the basis of these reports a summary of the weather is prepared, and synoptic charts are drawn up, with a forecast for the following day. A report is delivered to the Telegraph Office between 2h. 30m. and 3h. p.m. for transmission to subscribers, the telegraph authorities granting a considerable reduction on their ordinary rates.

The Central Office.

7. The Central Office, which is located at Zürich, has been a Government institution since the 1st May 1881. It is not at present an observatory, but only a central office for the collection, publication, and discussion of the observations. It is superintended by a scientific commission appointed by the State, and consisting of seven members. The Commission holds one or two meetings a year for the consideration of questions of organisation, and for preparing the estimates. The Central Office has not yet a building of its own, but is at present located in the private house of its Director. It possesses a number of instruments, which are, however, not used for regular observations, but only for occasional investigations, and for checking other observations.

The staff.

8. The staff consists of the Director and an adjunct, appointed by the Federal Council, and assistants appointed by the Director. The latter, in 1882, numbered three computers. The salary of the Director is 180*l.* to 200*l.*, that of the adjunct, 100*l.* to 120*l.* The computers are paid 48*l.* to 60*l.* for seven hours work daily.

From 12 to 15 of the observers (the number varies from year to year) receive from 2*l.* to 4*l.* on returning uninterrupted and reliable registers. Most of the observers, however, decline any remuneration.

Publications.

9. The publications of the Central Office are :—

(*a.*) "*Annalen der schweiz. meteorol. Centralanstalt*," which formerly appeared under the title "*Schweizerische meteorol. Beobachtungen.*"

(*b.*) Daily weather reports.

The first publication contains the results of the observations of all the stations, and a supplement with meteorological discussions; the second contains the weather reports from about 14 Swiss stations, and a chart containing also foreign telegraphic weather reports and a summary, with a forecast for Northern Switzerland.

Management and inspections.

10. The stations are managed by the Central Office. The Director or the adjunct conducts the correspondence, and the latter represents the Director during his absence. The Director undertakes the management of the financial administration of the Central Office and stations.

The inspection of the stations and verification of the instruments at the stations (Kew thermometers and check barometers by Fuess) with standard instruments, are also undertaken by the Director and adjunct. Each station has to be inspected at least once in three years.

Supplementary remarks.

11. Free postage, the same as is enjoyed by public offices, is allowed for the official correspondence of the Central Office and stations.

Historical.

12. Meteorological observations were made in the last century at various places in Switzerland, and have been partially published in the earlier volumes of the "Annals of the Central Observatory." These, however, have only a local importance and are not comparable, owing to the uncertainty as to the quality and exposure of the instruments, and to the diversity of hours of observation. Upon the proposal of M. A. Pictet, a commission of the Swiss Naturalist's Society was appointed in 1823, for the purpose of organising a system of meteorological observations. Good instruments were erected at 12 places Lausanne, Berne, Basle, Geneva, Solothurn, Lucerne, Aarau, Zürich St. Gall, Chur, Bellenz, and Schaffhausen, and afterwards on the St Bernard and at Bevers, and observations were taken on a uniform plan. Details of the observations were printed in various publications, but owing to the want of central guidance, for which there were no funds at that time, the undertaking led to few results.

At the beginning of 1860 a plan for a system of meteorological observations was again discussed by the Swiss Naturalist's Society, and was carried out in 1863 by its permanent Meteorological Commission, of which Professor R. Wolf, Director of the Federal Observatory at Zürich, was for many years president. The Government (The Federal Council) assisted the undertaking by a yearly grant, amounting at first to 440*l.*, and afterwards increased to 600*l.* The Cantons also subscribed something towards the publications. As it was gradually found that practical interests were involved, besides the first merely scientific importance of the meteorological observations, the Meteorological Commission itself proposed to the Federal Council, with especial regard to Resolution 23 of the Vienna Congress—according to which each country should establish a Government office, for the superintendence, collection, and publication of meteorological observations—the re-organisation of the Central Meteorological Office and its elevation to the rank of a Government institution. In accordance with the decree of the Council this took place on the 23rd December 1880. On the 1st March 1881 the Central Meteorological Office of the Naturalist's Society, which generally had only the name of "Meteorological Office" was closed, and the "Swiss Central Meteorological Office" took its place, as a Government Institution, under the Federal Department of the Interior, independent of the Naturalist's Society. The chief of the former office was appointed Director of the new Institute.

THE UNITED STATES.—MISSOURI.

Professor F. E. Nipher, Physical Laboratory, of Washington University, St. Louis.

The Missouri Weather Service is not a State or Government institution, but is carried on wholly on private means. It is wholly a volunteer service, and is conducted not on account of what it is now doing, but with a view of finally securing the organisation of a Weather Service and a system of harvest warnings as a State institution.

At present we only attempt to observe rainfall and occasional phenomena.

The work has been carried on since 1877.

It is possible that in course of eight or ten years the State Government will see the advantages of having the work done in a more thorough and business-like way, and will extend the necessary co-operation. Until then we are only aiming to keep the sacred fires burning.

I. The aim is to make rain observations and observations on phenomena.

II. We have no stations where complete observations are made.

III. The instructions are those of the International Congress so far as observations are taken.

IV. It is impossible, under present circumstances, to give the attention to the direction of observers work, necessary to secure uniformity or completeness of observations on phenomena. Stations 35 in number.

VII. At the Central Office observations are taken at 7, 2, 9, on temperature, pressure, sky, and maximum and minimum temperatures are observed.

VIII. The director is assisted by a student who receives a nominal salary of $150 a year.

IX. Monthly bulletins are published, but no other publications of a strictly meteorological character have appeared.

X. There is no regular inspection of stations.

XII. Observations began December 1, 1877.

APPENDIX XII.

Royal Observatory, Brussels.

Replies to Appendix V. of the Report of the Congress at Rome *. (*Received April* 1882).

1°. Our system possesses 116 stations:—

(*a.*) 4 of the First Order.
(*b.*) 38 of the Second Order.
(*c.*) 38 of the Third Order.
(*d.*) 36 of the Fourth Order.

2°. All the stations of the First, Second, and Third Order are provided with instruments. The stations of the Fourth Order are stations for the observation of thunderstorms only. The Stations of the First Order possess van Rysselberghe's meteorograph and instruments for direct reading; the Central Station at Brussels possesses besides a complete collection of photographic self-recording instruments.

The stations of the Second Order are furnished with a Baudin's barometer (graduated on the tube), Baudin's meteorological frame (maximum and minimum thermometers and dry and wet bulb thermometers), and a rain gauge.

The stations of the Third Order have only a rain gauge.

All the observations, both direct and automatic, are published in the "Meteorological Annals of the Royal Observatory of Brussels" and in the "Meteorological Observations made at the International Stations of Belgium and of the Netherlands." In this last collection the observations made each day at the four stations of the First Order at 8h. a.m., and at 1h. p.m. are published; in the Meteorological Annals the complete observations at Brussels for every two hours, the monthly *résumés* of the stations of the Second and Third Order, and the annual discussion of thunderstorm observations are to be found.

3°. All the stations are inspected yearly, or at least every two years, by the inspector. All the barometers were compared at the stations in 1877, and most of the thermometers are verified each year by the observers themselves. Comparisons are also made by the inspector, at the time of his annual visits. All the instruments, with very rare exceptions, are of suitable construction, all are carefully checked and compared at the Observatory before they are sent to the observers.

4°. At Brussels, six times a day:—8, 9, Noon, 1, 3, and 9. At-all the other stations, twice a day, 8h. a.m. and 1h. p.m.

5°. The observations are entered on printed forms furnished by the Royal Observatory at Brussels. These forms are sent to Brussels during the first days of each month.

6°. The cost of these forms is borne by the Central Office.

7°. All the observers are volunteers; three only receive a slight remuneration. The Central Office repays the cost of postage of the monthly forms if claimed. The observers offer their services voluntarily.

8°. They are only changed at their own request.

9°. The stations are generally inspected between July and October.

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* See also replies at p. 42.

10°. By the inspector and at the expense of the Central Office.

11°. The instruments are generally furnished by the Observatory, some observers purchase them.

11A°. They are all compared and verified at Brussels before being sent to the observers. They are verified again during the annual inspections.

12°. A director, a meteorologist in charge of the service, an inspector, a meteorologist, a joint meteorologist, and two assistant meteorologists.

12A°. None.

12B°. From 9h. a.m. till noon, and from 1 a.m. till 4h. p.m., except the joint meteorologist who attends from 8h. a.m. till 3h. p.m.

12C°. The director has free apartments in the Observatory.

13°. The director superintends the general work of the meteorological department, undertakes the correspondence with the Government and with foreign countries. Once a month he assembles all the meteorological staff in his office, in order to discuss questions relating specially to the service. It should be observed that the Brussels Observatory comprises two distinct departments, Astronomy and Meteorology, both entrusted to the same director.

All the staff takes part in the observations, but the joint meteorologist undertakes the greater part of them; the whole staff also takes part in the reduction of the observations.

The meteorologist in charge of the service and one of the assistant meteorologists have principally the charge of the self-registering instruments.

The inspection of the meteorological stations and the correspondence with the stations are undertaken by the inspector, who is also the librarian of the Observatory.

The discussion of the thunderstorm observations is also done by the inspector.

The meteorologist in charge of the service is almost exclusively occupied with the reduction of the observations made by the van Rysselberghe Meteorograph.

The daily weather report is drawn up by the joint meteorologist.

14°. The three meteorologists are nominated by the King, the other officials by the Minister of the Interior.

15°. Mean salaries: The director, 320*l.*; the meteorologist in charge of the service, 200*l.*; the inspector and the meteorologist, each 96*l*; the assistant meteorologists, 48*l.*

16°. The salaries are paid by the Government.

16A°. The salaries are permanent, and rise from a minimum to a maximum. All the officials have the claim to superannuation after 65 years of age, and 50 years of service.

16B°. Any funds remaining from the vote for salaries serves to pay the cost of additional or extra work. This residue is variable, on an average about 40*l.*

17°. The following are the meteorological publications of the Observatory:—

1°. Annals, of which the first volume of the third series has just appeared.

2°. Meteorological Observations taken at the International Stations of

Belgium and the Netherlands, 1877–79; published in co-operation with the Meteorological Institute of Utrecht.

3°. Weather Report, published daily since the month of September, 1876.

4°. *Annuaire*, published yearly, but which is a publication referring to the whole of the Observatory, and not to the meteorological service only, 1833–81.

17A°. There is a special fund for the printing of the different publications.

17B°. About six hundred copies of the publications are distributed at home and abroad, excepting the Weather Report, of which only about two hundred copies are distributed free.

17C°. The publications are not on sale, excepting the Weather Report and the *Annuaire*. The former numbers about 300 subscribers; the sale of the latter amounted this year to 1,300 copies. It is sold at the profit of the printer, who prints extra copies for this purpose.

18°. The daily observations of the Stations of the First Order are published.

For all the other stations only the monthly results are published.

19°. The discussion of the thunderstorm observations only forms a part of the regular work of the Observatory. The study of all the other meteorological questions forms a part of the voluntary work of the staff.

20°. The staff is constantly occupied with improvements or modifications to be introduced in the instruments. One of the meteorologists, M. van Rysselberghe, is well known by the invention of his universal meteorograph. Comparisons of instruments based upon the same principle but of different construction, are frequently made.

21°. 1°. 240*l.* for the first outfit of the stations.

2°. Stations without cost in public establishments, or belonging to private persons.

3°. Most of the observers are volunteers, three receive altogether about 6*l.* 10*s.*

4°. 60*l.* a year for gas, and maintenance of batteries.

5°. 4*l.* a year.

6°. 16*l.* a year.

7°. 12*l.* a year.

8°. No storm warnings.

9°. No vote for this purpose.

22°. The Observatory of Brussels occupies itself with the meteorology and magnetism of the Globe, and, in a certain point of view, with maritime meteorology. The mail-packet boats which run between Ostend and Dover are provided with instruments by the Observatory; the lightships of Westhinder and Weislingen constitute Stations of the Second Order. The Observatory sends a daily notice to the ports, and in case of barometric depressions, it sends a notice to the mines.

Replies to Appendix VIII. of the Report of the Congress of Rome.

4. Continuous observations, by means of self-registering instruments, have been made at the Brussels Observatory for 40 years; lately van Rysselberghe's meteorographs have been erected at Ostend, Arlon, and Maeseyck, that is to say, at the three angles of the Belgian territory.

5. The observations are published in accordance with the forms proposed by the Congress of Vienna.

6. The figures adopted for meteorological telegrams are the same as those proposed by the committee.

9. The Observatory of Brussels will very shortly draw up the list of printed and manuscript observations made in the country. It is also preparing a second edition of the catalogue of the library, considerably augmented.

10. The standard barometer and thermometer of the Observatory were compared at Kew Observatory during 1880.

13. M.M. Quetelet, senior and junior, have published various memoirs on the range of temperature at Brussels. M. Lancaster published last year a work on the thunderstorms in Belgium.

14. The Brussels Observatory possesses specimens of various kinds of self-registering instruments—van Rysselberghe's, photographic, Kreil's, Osler's, Thomson's, &c.

15. The reduction of the barometer to sea-level is done in accordance with the decisions of the Congress.

17. Stevenson's screen has hitherto been employed. Latterly Renou's screens, with double roof and without louvres, have been erected. Comparative experiments on the two systems will be commenced soon.

23. For a long time the wind-force was measured by Osler's anemometer, which indicates, as is known, the pressure of the wind in kilograms. Since 1878 this instrument has been replaced by Robinson's anemometer, which measures the velocity of the air in motion. It was soon found that the indications of one of these instruments alone was not sufficient for the study of the various questions relating to the force of the wind, and it is proposed to observe both instruments at the same time when the new Observatory is built.

24. We are erecting an instrument which will enable us to studyt distribution of atmospheric electricity in successive strata of air placed in the same vertical.

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REPORT

OF

THE THIRD MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE

HELD AT PARIS, SEPTEMBER 1885.

Published by the Authority of the Meteorological Council.

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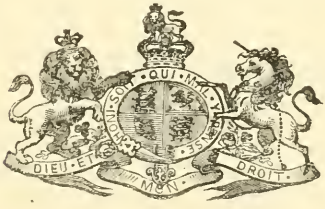

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REPORT

OF

THE THIRD MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

PARIS, SEPTEMBER 1885.

Protocol of the First Meeting, 1st September 1885.

THE MEETING was opened at the Ministry of Public Instruction at 10h. 15m. a.m.

Present: MM. Wild (President), Buys Ballot, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

The PRESIDENT, after having welcomed the members who were present, stated that unfortunately M. de Brito-Capello had been prevented from attending the Meeting.

The PRESIDENT proposed that General Hazen, of Washington, and Professor Hildebrandsson of Upsala, who were at present in Paris, should be invited to take part in the meetings.

This proposal was adopted.

The PRESIDENT requested the Secretary to read the Programme of Questions for discussion proposed by the Executive Officers.

The Programme was read and adopted, together with some supplementary articles proposed by M. Neumayer. (Appendix I.)

The PRESIDENT requested the Secretary to read his Report (Article I. of the Programme).

The Report was read and adopted. (Appendix II.)

The discussion was opened on Article II. of the Programme:—

"Report of MM. de Brito-Capello, Hildebrandsson, and Ley on the observation of Cirrus Clouds." (Appendix III.)

M. HILDEBRANDSSON, who presented to the members of the Committee a Report in the name of the Sub-Committee nominated at Copenhagen (Appendix III.), gave, on the invitation of the President, detailed explanations of the work done by the Sub-Committee, and submitted a model of a nephoscope recently invented by M. G. Fineman at Upsala, for the observation of clouds.

M. MASCART expressed his opinion that the question was of the greatest interest for all meteorologists. It would be very useful to introduce particulars about cirrus clouds in the reports from telegraphic stations.

E 21513. Wt. 5.

M. TACCHINI remarked that it would be of importance to make these observations at two stations of different heights. It sometimes happened that cirrus observations could be made at very elevated stations, while in the plain these clouds could not be seen at all, owing to the existence of a lower stratum of clouds.

M. HILDEBRANDSSON replied that there were clouds which he called "false cirrus," which were seen at relatively small heights (4,000 metres), and which were connected with thunderstorms.

Mr. SCOTT recalled the attention of the Committee to the fact that a commencement of introducing cirrus observations into the telegraphic reports* had been made in England several years back, and he stated that he shared the opinion of M. Tacchini that these clouds were sometimes subject to local laws.

The decision upon the proposals of the Sub-Committee was adjourned, in order to give the members time to study the printed report.

The discussion was opened on Question III. of the Programme :—

"Does it appear opportune to convene at an early date a third International Congress?"

The PRESIDENT reminded the Committee of the steps taken since the meeting at Copenhagen to convene a third Congress of meteorologists, according to the decisions of the Congress at Rome.

Several members were of opinion that it would be opportune to extend the action of the Committee by the convening of a Congress.

M. MASCART also thought that it would not be well to postpone for too long a period the convocation of a Congress. In the event of this opinion being adopted, he thought he could assure the members that the French Government would be very happy to receive the Congress at Paris in 1889, at which time there would probably be an International Exhibition in that city.

M. NEUMAYER said that he had already had the honour, on the occasion of the meeting of the International Meteorological Committee at Copenhagen,† to declare that it was the opinion of the German Government that a third Meteorological Congress would at present be devoid of any special object. For that reason he had already spoken against the convocation of a Congress. By a communication, dated the 15th June last, he was directed by the Secretary of State to inform the Committee on the part of Germany, that that country was not disposed to favour the idea of an International Meteorological Congress, and that in consequence, he could not hope for an official participation of his Government in it. But he had no observations to make against the more distant date indicated by M. Mascart.

M. TACCHINI moved that as it was not possible at present to come to any definite decision, M. Mascart's proposal should

* Report of the International Committee, Copenhagen Meeting 1882.

† Report of the International Meteorological Committee 1882, Copenhagen Meeting, p. 10.

be taken into serious consideration, and this suggestion was unanimously adopted.

The meeting was adjourned at noon until 2h. p.m. On the sitting being resumed, M. HILDEBRANDSSON read a letter from Baron de Capanema, of Brazil, in which he requested the Committee to elect him as a member of the Committee.

The SECRETARY was requested to forward to Baron de Capanema a copy of the Resolution of the second meeting at Copenhagen, on the constitution of the Committee, with the expression of deep regret that the Committee could not accede to his request.

The PRESIDENT was further requested to express to Baron de Capanema the profound interest with which the Committee had received the information he had furnished as to the efforts which Brazil is at present making to organize a regular and extensive system of meteorological observations.

The discussion was opened on Question IV. of the Programme:—

"The establishment of Stations of the First Order on the River Congo."

The PRESIDENT submitted to the Committee the correspondence that he had carried on with the approval of the majority of the Committee, with Baron Strauch, the General Secretary of the Congo Association. He read the following documents:—

(1.) An article by Baron von Danckelman on the question, published in the Journal *Ciel et Terre* (15th July 1885). Appendix IV.

(2.) A letter from M. de Brito Capello with reference to Portuguese stations in the vicinity of the river. Appendix V.

(3.) A letter from M. Mühry on the importance of stations in tropical countries. Appendix VI.

On the subject of M. Capello's communication, which was received with interest by the Committee, M. HANN remarked that the attention of the Congresses of Vienna and Rome had been specially directed to the organisation of stations provided with self-recording instruments in the interior of tropical continents, because the range of the meteorological elements in these geographical conditions was at present entirely unknown. In those regions stations existed, or had existed, only upon the sea coasts (*e.g.*, Batavia, Singapore, Trevandrum, &c.).

The upper parts of the Congo, and of the Amazons, were especially suitable for the establishment of one or more stations provided with self-recording instruments.

M. MASCART said that he had already furnished the means for organising stations in the French possessions on the Congo; but information as to the results hitherto obtained was still wanting.

M. HILDEBRANDSSON informed the Committee that several Swedish officers were engaged in the service of the Congo Association and that meteorologists might rest assured that these

gentlemen possessed all the aptitude necessary for furnishing excellent observations.

As to the Amazons, he informed the Committee that the Director General of the Telegraphic Service in Brazil, Baron de Capanema, had, by order of the Emperor, commenced the organisation of a system of meteorological stations at the telegraph stations of the empire. Four printing meteorographs on Theorell's pattern, made at Stockholm by M. Sörensen, under the supervision of M. Hildebrandsson, were ready for transmission, to be erected at four stations of the First Order in Brazil.

M. NEUMAYER informed the Committee that a Colonial Association in Germany had evinced much interest in the progress of meteorology, and that it had taken measures for obtaining accurate information about climatology by the help of trained observers, at least for New Guinea, the Cameroons, and the Herero Land.

M. MASCART proposed the following resolution : —

" *The Committee has received with great interest the communication of the efforts which have been made by different countries for the establishment of permanent observatories of the First or Second Order in equatorial regions, especially in the empire of Brazil, in the Portuguese Colonies on the Congo, in New Guinea and New Britain by Germany, as well as in the French possessions. It expresses especially the desire that these stations may be extended as much as possible into the interior of the continents, in order to facilitate general studies on the march and distribution of the meteorological elements on the surface of the globe. The Committee will further readily co-operate with any persons who may be disposed to organise observations of this nature.*"

This resolution was adopted unanimously.

The PRESIDENT read a letter from M. Billwiller (dated 25th August 1885, Appendix VII.), which contained a report upon the condition of the Observatory on the Säntis, together with a *résumé* of the results obtained since the 1st September 1882.

The Committee requested the Executive Officers to thank M. Billwiller for the communication of his interesting report on the station on the Säntis, and to express to him its great satisfaction at the establishment and excellent working of this elevated station which would furnish most valuable data for the science of meteorology.

The meeting closed at 3h. 50m. p.m.

(Signed) H. WILD.

Protocol of the Second Meeting, Wednesday, 2nd September, at 9h. 30m. a.m.

Present: MM. Wild (President), Buys Ballot, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

The protocol of the first meeting was read and confirmed.

The discussion was opened on Question V. of the Programme :—

"Discussion upon the utility of the weather summaries published in different countries and the eventual preparation of a more uniform plan."

On the invitation of the President the different members explained to the Committee the methods actually in use in their respective countries for publishing weather summaries, &c. for the use of meteorologists and other persons who required them.

It resulted from the discussion that the publication of these summaries had especially a local and practical interest, and was at the same time an encouragement to observers, so that there was no occasion to apply in this case the resolutions of the Congress as to the uniform publication of the observations in different countries.

The discussion was opened upon Question VII. of the Programme :—

"How is it possible to ensure the receipt of meteorological telegrams in time to be of use."

The SECRETARY read the letter from M. Capello upon this question. (Appendix VIII.)

After a long discussion the Committee adopted the following resolution :—

"*The Committee has heard with great interest the reading of M. de Brito-Capello's letter, which deals with one of the most important points connected with meteorological forecasts. The telegraphic service generally works in a satisfactory manner, in most parts of Europe, thanks to the liberality of the Telegraphic Administrations. The telegrams from Spain and Portugal, however, often suffer very regrettable delays, notwithstanding the zeal of our colleagues. The method of the elevation of the rank of such telegrams proposed by M. Capello appears to be difficult of realisation; but the Committee considers it very desirable that the greatest efforts should be made with the different Telegraphic Administrations to obtain a more rapid transmission of these telegrams generally, and especially of the telegrams from the Iberian Peninsula.*"

The discussion was opened on Question VIII. of the Programme :—

"Should the reduction of barometric readings to the gravity of latitude 45° be generally introduced."

M. MOHN explained the considerations that had led him to the opinion that it was desirable to introduce in all publications the reduction of the barometric reading to the latitude of 45°, in the same way as the reduction to 32° F.

The following resolution was adopted on this point :—

"*The Committee, while considering that it was desirable to introduce the reduction to the latitude of 45° in barometric observations, does not consider itself authorised to make a definite resolution, and therefore postpones the question until the next Congress. In all cases the institutions which intend to adopt this measure from*

the present time are requested to state at the head of the published tables and charts that the correction for gravity has been applied."

The discussion was opened on Question X. of the Programme :—

"Is it desirable in meteorology to reckon the hours of the day from 0h. to 23h., in accordance with the resolutions of the International Conference at Washington."

The Committee did not think it opportune to make a general resolution upon this question at present. It merely requested all meteorologists who reckoned the hours of the day from 0h. to 23h. to adopt the civil day, viz., to commence at midnight.

The meeting closed at 11h. 50m. a.m.

(Signed) H. Wild.

Protocol of the Third Meeting, Thursday, 3rd September, 9h. 20m. a.m.

Present : MM. Wild (President), Buys Ballot, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

The protocol of the second meeting was read and confirmed.

The discussion on Question II. of the Programme (p. 2) was resumed, upon which the following decision was adopted :—

"The Committee recommends the observation of the movements of the clouds, especially of cirrus, in accordance with the scheme drawn up by the Sub-Committee which is annexed to its protocols (Appendix III.), and the introduction, at least for some stations, of these data into the meteorological reports."

The Committee also decided to print in the same Appendix M. Hildebrandsson's recommendation as to the method of observing clouds.

The discussion was opened on Question VI. of the Programme :—

"The discussion of the utility of the meteorological telegrams from America proposed by General Hazen, and the eventual organization of their distribution in Europe."

M. Leon Teisserenc de Bort was present by invitation, and communicated to the Committee particulars as to the method which he proposed for a daily telegraphic service between Europe and North America. (Appendix IX.)

Mr. Scott stated that, after the experience of eight months of the reports furnished by ships' logs, it was found in England that it was quite necessary to add the latitude of each observation to the reports.

He also shared the opinion of M. Teisserenc de Bort, that if the expense were not too great, it would be desirable to obtain daily résumés of the distribution of pressure, &c. over the eastern part of the United States.

It was agreed for discussion to divide the question into three parts :—

A. The general utility of such reports at the present time.
B. The form that should eventually be proposed for them.
C. The method of fixing and distributing the probable expense.

M. Buys Ballot approved of the idea of M. Teisserenc de Bort as a step in the right direction, which would render easier the assistance offered by General Hazen. In order to take full advantage of the telegrams from ships, it was also absolutely necessary to know generally the state of the weather in America, and this general knowledge might be well furnished by the types which could be modified as found to be necessary.

M. Mohn asked whether it had been shown that the telegrams from America were of any material utility for the purpose of weather forecasts in Europe. He mentioned to the Committee the opinion expressed by the late Captain Hoffmeyer, that it was only a knowledge of the state of the weather over the eastern part of the Atlantic (viz. Greenland, Iceland, and the Azores), that could give certain indications as to European weather.

Mr. Scott remarked, in reply to M. Mohn, that no one could deny the importance of an announcement, that a storm was raging at, say, a distance of 100 miles from the coast of Ireland. But such reports could not be sent. The best that could be done was to send a telegram to Valencia, giving information about the storms, &c. met by a vessel in mid-ocean, as soon as that vessel touched an American port. The service now carried on between Washington and London is of this character.

M. Neumayer said that, notwithstanding all due respect which he felt for the importance of M. Teisserenc de Bort's proposal to obtain by telegraph from the United States all the reports which might be of use in the study of meteorological phenomena on the continents of America and Europe, he wished to suggest that in all investigations of this kind, a knowledge of the state of the weather over the Atlantic Ocean would be absolutely necessary, for how could we supply the missing observations of the immense space in which, as it is well known, great changes occur? From the experience of the Seewarte during the last eight years such data could only be obtained after an interval of six or eight weeks. The transmission of observations from ships, as proposed, in 45° West Longitude, was not sufficient for a study of this kind, and especially for affording a certain basis for framing a forecast of European weather.

For the purpose of issuing a practical weather forecast, there would be little to be gained by knowledge of the condition of the weather over the continent of America, without having also precise information respecting its condition across the North Atlantic Ocean. For this purpose it would be necessary to have 50 or 60 detached positions distributed across the whole extent of that ocean. But this investigation might be carried out, after a considerable lapse of time, without telegraphic reports. The importance of telegraphic reports of extracts from ships' logs for the purposes of practical navigation, even though restricted to the region to the west of 45° W. longitude, was beyond all doubt. We should endeavour, therefore, to obtain these telegraphic reports before we

arranged for the receipt of telegrams of the state of the weather in America. Further, it would not appear to be opportune to take into consideration the other side of the Atlantic, while we are only just beginning to improve the conditions of weather telegraphy in Europe, which is not very satisfactory, inasmuch as there still exist large territories, like Portugal and Spain, which are almost entirely omitted from the telegraphic weather service.

In M. NEUMAYER'S opinion we should carefully consider methods of improvement, and assist the telegraphic authorities in effecting desirable concessions, by proposing only what is of the greatest importance.

The improvements in Europe, and the telegraphic reports of ships' logs, although only from a region limited on the eastern side, are objects that appeared to him (Dr. Neumayer) of the highest importance, and which we should make the greatest efforts to obtain.

M. MASCART thought it would be premature to express at present any opinion as to the utility of reports from the Atlantic; we should wait for the results of a longer experience, when it may have become possible to improve the service in the manner indicated by practice. The knowledge of the general conditions over the United States would no doubt assist us in interpreting better the information furnished by ships.

M. TACCHINI was also of opinion that we should not yet decide upon the utility of the telegrams from America; at present the Committee should be content to obtain the telegrams, leaving every one free to procure them or not, and with this object he proposed: (1°) to ask General Hazen whether the Signal Office could send the telegrams each day direct from Washington; (2°) to recognize that it would be practicable to adopt for these telegrams a form analogous to that proposed by M. Teisserenc de Bort; and (3°) to calculate now what would be the cost of each telegram.

The sitting ended at 10h. 50m. a.m.

(Signed) H. WILD.

Protocol of the Fourth Meeting, Friday, 4th September, 9h. 40m. a.m.

Present: MM. Wild (President), Buys Ballot, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

General Hazen was present by invitation.

The protocol of the third meeting was read and confirmed.

The discussion upon Question VI. of the Programme was resumed.

General HAZEN assured the Committee that his office was quite willing to send to Europe daily despatches on the state of the weather in America.

It resulted also from the discussion that the probable cost of the daily despatches from Washington, such as M. Teisserenc

de Bort proposed, would be at most about 5,000 francs a year, to which ought to be added a similar sum for the despatches from ships.

Messrs. Buys Ballot, Hann, Neumayer, Mascart, Tacchini, and Wild announced that they were ready to recommend to their Governments to contribute to this expense.

M. Neumayer remarked that it seemed to him, from the discussions of yesterday and to-day, that there was not among the members of the Committee that clear idea of the subject that was necessary. The essential part of the question had remained too much in the background, owing to the somewhat premature communication of the proposal of M. Teisserenc de Bort, but he thought that a thorough discussion of the object in view would be very desirable, and that the appointment of a special Sub-Committee would be the most suitable course, for the purpose of examining the question and of reporting the results to the Committee, and especially with the view of ascertaining the ideas of General Hazen, upon which everything would at first depend. He proposed the appointment of a special Sub-Committee consisting of Mr. Scott and himself, to discuss the subject with General Hazen and prepare a report by the next meeting.

This resolution was carried.

The discussion was opened on Question IX. of the Programme, (Appendix X.) :—

"The method of the reduction of barometrical readings to the level of the sea for synoptic charts." (Proposal made by General Hazen.)

MM. Wild and Neumayer submitted special reports upon this question. (Appendices XI. and XII.)

The Committee did not adopt any resolution upon this subject, and it was agreed to print these reports as well as General Hazen's letter as Appendices.

The discussion was opened on Question XI. of the Programme :—

"The designation of the form of clouds when the sky is entirely overcast."

It was decided to add nothing about the form of the clouds when the sky was uniformly overcast.

The discussion was opened on Question XII. of the Programme :—

"The determination of a zenithal zone for the estimation of the amount of cloud."

M. Wild gave some explanation as to why he thought it useful to draw the attention of meteorologists to this question. These were especially the results of an investigation by M. Laurenty, of the Pawlowsk Observatory, "*Sur les erreurs personnelles dans l'estimation du degré de nébulosité*," published in Vol. X. of the *Repertorium für Meteorologie* which demand for the observation of the amount of cloud the restriction to a zenithal zone, for

instance, 60°, in order to render more comparable the estimations made by different persons and at different places.

M. Hann thought that it would be well to recommend stations of the First Order to compare the estimated amount of cloud according to the present system with the method of taking into consideration only a zenithal zone, for instance, 60° or 45°, as is done in Scotland. This proposal was adopted.

M. Neumayer requested the Committee to take into consideration the opinion of M. Galle, of Breslau, as to the definition of halos and coronæ. He submitted the following remarks upon this subject:—

"As the Meteorological Congress at Vienna has not given any definition, a difference of opinion in the interpolation of the symbols has arisen which should be rectified.

"The only designation given by the Congress for these symbols consisted in the addition of the German words '*Ring*' and '*Hof*.'

"These expressions, however, have by the important work of Galle* received a signification which is established in scientific language, and designate respectively the corona and the halo of 22° radius. It is therefore necessary to make the definitions precise in order to avoid errors which might give rise to incorrect interpretations. Moreover, it might be recommended to place the symbols for the phenomena in the horizontal position (thus) ⊖ ∋, in which they would be easily recognised and would take up less space than in the vertical position ⊖ ∪.

The Committee requested M. Neumayer to enter into correspondence with M. Galle and to communicate the result to the Executive Officers.

The discussion was opened upon Question XIII. of the Programme:—

"The definition of days of rain and snow."

The Committee referred to the fact that the International Polar Committee had adopted 0·1 mm. for the minimum quantity which serves to define a "wet day," and reserved a definite decision on the point for a future Congress.

The sitting ended at 20 minutes past noon.

(Signed) H. Wild.

Protocol of the Fifth Meeting, Saturday, 5th September, 9h. 30m. a.m.

Present: MM. Wild (President), Buys Ballot, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

The protocol of the fourth meeting was read and confirmed.

General Hazen was present by invitation.

M. Mascart communicated the following letter:—

"M. le Directeur,

"I should have been very happy to have given audience to the members of the International Meteorological Committee,

* "Paggendorff's Annalen, Vol. xlix., 1840."

and thus to have had an opportunity of welcoming them personally. But as yesterday I only passed through Paris, I much regret that I have had to forego the pleasure of receiving those gentlemen. I request you, M. le Directeur, to be good enough to present my excuses to your eminent colleagues, and to convey to them the expression of my most devoted sympathy.

"Accept, &c.

(Signed) GOBLET,

"Minister of Public Instruction,
Fine Arts, and Worship."

The Committee requested M. Mascart to be good enough to return its thanks to the Minister for his kindness and his hospitality towards them.

The Report of the Sub-Committee nominated at the last meeting on the question of Atlantic weather reports was read and adopted. (Appendix XIII.)

The Committee unanimously adopted the following resolution :—

"*The Committee has followed with the greatest interest the experiment of Atlantic reports inaugurated by its meteorological colleagues of London and Paris, and it is of opinion that an endeavour should be made to give greater development to that service.*

"*The Committee particularly expresses its very cordial acknowledgments of the great service which the Signal Office of Washington renders to science in the organization of these reports.*"

The discussion was opened on Question XIV. of the Programme :—

"Should not the general adoption of a uniform height above the ground for rain-gauges be recommended."

Letters were read expressing the opinions of MM. de Brito-Capello and Symons upon this question. (Appendix XIV.)

M. MOHN drew the attention of the Committee to the resolutions upon this subject adopted by the Congresses of Vienna and Rome.

M. WILD remarked that the definition given at the Vienna Congress as to the proper height for rain-gauges had been modified by the decision taken at Rome.

M. BUYS BALLOT thought it would be useful to remark, with reference to the communications made by M. de Brito-Capello, that if a change were made in the exposure of rain-gauges, simultaneous comparative observations ought to be made as a check, as in the case of changing other instruments.

The following resolution was adopted :—

"*The Committee, while reserving for the future Congress any change of the decision taken at Rome upon this question, thinks that it should recommend comparative observations to be made to determine the influence of height on the indications of rain-gauges in different countries ; and it further recommends, in case of changes of height, that comparisons should be made for some time between*

the old and new gauges, as has been recommended in the case of other instruments."

The discussion was opened on Question XV. of the Programme :—

"What progress has been made recently for the more exact measurement of snow."

The opinions of the Rev. Padre Denza and of Mr. Symons were read. (Appendix XIV.)

Several members expressed the opinion that it was impossible to obtain satisfactory observations of this phenomenon.

M. WILD was of a contrary opinion. As he had just published in a special memoir "*Sur l'influence de la qualité et de l'exposition des pluviometres sur leur indication*" (*Repertor. für Meteorologie Bd. IX. Nr. 9*), he had collected very nearly the same quantities of snow with his exposure of an ordinary rain-gauge surrounded with wooden planks of 2½ metres, and with a rain-gauge fitted with a protecting funnel in accordance with Nipher's instructions. He thought, therefore, that meteorologists were very near a satisfactory solution of this question.

M. TACCHINI remarked that for the measurement of snow he had adopted a receiver in the form of a truncated cone, of which the upper opening was of the same size as that of the rain-gauge.

The following resolution was adopted :—

"*The Committee, while recognising that some progress had been made in the exact measurement of snow, thinks it necessary to continue investigations on this subject.*"

On this occasion the Committee thinks it useful to refer to the following definitions :—

Snowdrift.	Snowstorm.
Chasse de neige.	Tourmente de neige.
Schneetreiben.	Schnee Gestöber.

The discussion was opened on Questions XVI. and XVII. of the Programme :—

"The adoption of a standard anemometer for the determination of the velocity of the wind." (Proposal made by the Royal Meteorological Society.) (Appendix XV.)

"The general adoption of a uniform height above the ground of anemometers." (Do.)

The SECRETARY read the letter from the Royal Meteorological Society upon these questions, explained to the Committee the views of the Society, and drew special attention to the very serious differences which exist at the present time between the scales employed in different countries for estimating the force of wind.

Several members expressed opinions upon the subject.

M. BUYS BALLOT referred to the experiments of Dr. Snellen in the Polar regions, during the expedition of 1882, for checking the registration of the velocity of the wind by anemometers.

On a given signal he let fly little balloons inflated with hydrogen, another observer noting the moment at which the little balloon

passed a mark placed at a given distance. The true direction and the force of the wind were thus obtained at the same time.

M. Snellen now proposed to make further experiments at the camp of artillery at Oldebroek to test the influence of the wind velocity upon gun firing. By making such observations it would be possible from time to time to verify the indications of anemometers, and to prove whether these have changed.

M. Neumayer gave some information as to the results furnished by Recknagel's anemometers in Germany, which he considered fairly satisfactory.

M. Wild thought that there might be a means of rendering comparable the indications of anemometers of observatories necessarily placed at different heights and under different circumstances by comparing their data with those of an anemometer erected at a suitable height above the ground in a locality where the neighbourhood is open.

The Committee, after having heard the opinions expressed, thought the questions too complicated, and not yet sufficiently studied to take any resolution at present.

The discussion was opened on Question XVIII. of the Programme ("The International Meteorological Tables") :—

M. Hellman's letter (of the 27th July) was read. (Appendix XVI.)

M. Mascart announced that M. Gauthier-Villars was also ready to publish these tables.

Several publishers had offered to undertake the publication of the tables at their own expense. The Committee was of opinion that the manuscript should be prepared.

The Committee requested the members of the Sub-Committee nominated at Berne (MM. Mascart and Wild) to make definite arrangements, which should be communicated to the members of the Committee before the work was put in hand.

The sitting ended at 11h. 50m. a.m.

(Signed) H. Wild.

Protocol of the Sixth Meeting, Monday, 7th September, 10h. 10m. a.m.

Present: MM. Wild (President), Buys Ballot, Hann, Mascart, Mohn, Tacchini, and Scott (Secretary).

General Hazen was present by invitation.

The protocol of the fifth meeting was read and confirmed.

Monsieur General Hazen desired to say a few words before leaving the meeting :—

"I desire to thank the members of this Committee and particularly Monsieur Professor Mascart, for the very courteous reception of which I have been the object during this my first visit to the meetings of the Committee.

"In America we are very young as a nation and also very new to the study of meteorology ; and to contribute the most possible

to the progress of this science we ask the aid of the experience which you have acquired by long work.

"Our Government is very liberal and our work is pursued with activity and with incessant efforts to render it complete and useful, and I desire that we may be able to work in harmony towards this common end, which is to discover facts and true methods. There are no secrets in a science which is founded on a well-established basis of truth.

"I had hoped to invite the next Meteorological Congress to Washington, and I hope it yet, but I have been unable to overcome some difficulties which present themselves. Such an invitation cannot be given without the consent of Congress, and this it has not yet been possible to obtain."

The discussion was opened on Question XX. of the Programme:—

"A. Cannot the same time be adopted for all telegraphic observations taken in Europe, whether it be the same local time or simultaneous time? We should thus avoid the existing jumps of from 1—3 hours between neighbouring stations on both sides of the frontier, which distort the synoptic charts of the respective countries.

"B. How far could we provide for the possibility of filling up the meshes of the telegraphic reporting system, by the entry of at least a part of the observing hours for climatological stations and stations of the third order, for the purpose of special investigations? This would be of importance, especially for the warmer season, in which thunderstorms generally occur."

The opinion of M. Neumayer was read:—

"The more the manifest advantages brought about by the rules established by the International Meteorological Congresses and Conferences for the uniformity of observations, and the more the scientific discussions of meteorological phenomena are facilitated by synoptic charts, now published every day, the more embarrassing is the existing want of agreement in most important points.

"We shall not take literally the opinion expressed by the excellent Secretary of the Scottish Society, that if an agreement upon this point be not attained, all other points are only of secondary importance; we must nevertheless recognise that there is some foundation for it.

"How can we possibly determine the barometric gradient between two stations in a cyclone, or even in a thunderstorm, when the observations differ one, two, or even three hours, owing to the frontier of the country?

"Or how can we make an exact comparison of the barometric changes from 6h. p.m. to 8h. a.m. in the British Isles with those of 6h. p.m. to 7h. a.m. in France, of 8h. p.m. to 8h. a.m. in Germany and Norway, of 9h. p.m. to 8h. a.m. in Denmark and Sweden, and of 9h. p.m. to 7h. a.m. in Austria and Russia? We meet with these same difficulties in all synoptic discussions, and even in a great part of the climatological discussions.

"We should, perhaps, obtain much more conformity upon this point if the divergence of principles had not led to considerable complications, but if, on the other hand, it had been necessary to adopt the same simultaneous time, or the same local time.

"The differences which would exist between the phenomena, according to whether they are observed at the same local time or simultaneously, are not to be mentioned in the same category as the sudden jumps referred to above. For these differences of time, according to space, and with the same local time, increase in direct proportion with the distances. For these differences progress and increase in a continuous manner on the same parallel, and disappear at small distances; they have not, so to speak, any influence upon the steepness or the position of the gradient, and only amount to considerable values when very distant stations are compared. But between those distant stations there is only a slight physical connection between the phenomena, so that a material inaccuracy in observations made by local time has not been proved even by the most theoretical enthusiasts. At the same time the choice of the same local time offers both scientific and practical advantages.

"Primarily, we should aim at the elimination of the daily periods; and, secondly, at the convenience of observers, which permits of obtaining more observers and more observations per day, especially at sea, where simultaneous time is very inconvenient.

"The question whether local or simultaneous time should be chosen, and we wish to direct our efforts to attain an agreement on this, appears to be really only a practical one.

"We cannot deny that, in this respect, meteorological telegraphy and the recent Conference at Washington are arguments in favour of absolute simultaneous time, especially so far as concerns international investigations.

"But international systems may equally organise observations according to the same local time, without prejudice to other common work.

"We must observe, however, that it is an advantage in many researches to insert numerous stations upon the normal synoptic charts, so as to be able to compare strictly local phenomena with the general condition of the atmosphere.

"We would therefore recommend for this purpose the choice of a fixed hour, especially during the hottest days, in order to obtain a close network of uniform observations, to enable us to study the secondary atmospheric phenomena of depressions and the local characteristics of violent disturbances of the atmosphere.

"The old Mannheim hour of 2h. p.m. is fortunately adopted by the greater part of Europe, except unfortunately by Russia, Switzerland, and Belgium.

"In 1875, when the *Deutsche Seewarte* had to decide upon the choice of hours for its system, it was in the disagreeable position of being obliged to abandon the two combinations of hours used in Germany (6, 2, 10, and 7, 2, 9), because the observations which could be obtained in the morning had to correspond to those

adopted in the N.W. of Europe, and then in winter for France also, viz., at 8h. a.m.

"The hour of 2 p.m. could be retained; for the evening observations the *Deutsche Seewarte* would willingly have adopted 9h. p.m., the hour selected by the greater part of Europe; but with the view of obtaining an observation giving the change of weather better, it was necessary to give the preference to a division of the day into equi-distant intervals, especially as 8h. a.m. and 8h. p.m. were at the same time selected as international hours in the maritime system of observations, where the division of the day into watches is universally adopted. It did not, therefore, select 8h., 2h., 9h., like Denmark and Sweden, but 8h., 2h., 8h., like Norway, and like Holland in part.

"Although this example has been frequently followed, the authorities of the *Deutsche Seewarte* understand very well that these hours are less favourable for climatological purposes. The old Mannheim hours, 7, 2, 9, would be willingly adopted; in a word, they would willingly agree to an international arrangement, if such were possible."

MM. Mascart and Scott, while supporting the proposal in principle, called the attention of the Committee to the difficulty which would be encountered by changing the hours of observation. It was necessary to take into account the habits of the observers, which differed in various countries, and also the necessities of transmission by telegraph.

MM. Buys Ballot, Tacchini, and Wild thought, however, that it would be possible to take steps in that direction, and were disposed to support M. Neumayer's proposal.

The Committee did not consider itself authorised to make a resolution upon the subject. But it called the attention of the heads of the various services to the advantage of having a more uniform system by adopting, for instance, as nearly as possible, the hours 7h. a.m., 2h. p.m., and 9h. p.m., which appear to be most generally employed.

As to Question B., M. Neumayer did not press the Committee to make a definite resolution upon this subject.

The discussion was opened on Question XXI. (Publications of Observations from America) :—

M. Neumayer communicated to the Committee—

While the international form of publication has been rapidly introduced throughout the whole of Europe, it is to be regretted that it has not yet been adopted for any station in America, excepting Greenland and Santiago (Chili). Neither the Canadian system, that of the Signal Service, that of the Argentine Republic, nor the observatories at Havana and Rio de Cordoba, communicate their observations with that entireness and uniformity which are necessary for discussions.

Notwithstanding their relatively considerable size, the above-mentioned publications only contain resumés of different kinds, such as the mean daily temperature, &c. The Signal Service

publications are only Daily Weather Reports and Charts, with the exception of the supplements given in the Annual Reports. It is true that the former show the elements of the same observation, but not the successive observations of one station. Researches in which certain stations are taken as a basis, are rendered extremely difficult.

Meteorology would be greatly benefited by the publication of observations from 20 to 30 stations in Canada and the United States, including especially Pike's Peak and Mount Washington, together with the lower comparative stations. The same may be said with regard to some meteorological stations in Central and South America. The use of the international forms for these observation must possess in all cases the greatest advantages for meteorology and climatology, especially as the stations or systems specified represent conditions which differ in essential points from those of Europe.

I think it is superfluous to urge this proposal more fully upon the International Committee, because every one engaged upon meteorological and synoptic work knows the importance of it. I am also of opinion that the expression of the desire of the Committee would suffice for obtaining a change in the publications in question which would put them in harmony with the international publications.

All the members of the Committee agreed to make these representations to the heads of services in America.

M. Mascart announced that he was requested by M. d'Abbadie to call the attention of the Committee to observations of earthquakes, a subject which presents the greatest interest for the physics of the globe.

M. Tacchini reported that a Commission had been nominated in Italy for the purpose of establishing special observatories devoted to seismological studies, quite separate from the meteorological observatories.

The Committee could only refer to the resolution taken by the Congress of Rome upon this question.

The discussion was opened on Question XIX. of the Programme:—

"Modification of the rules for the administration of the International Meteorological Committee."

The following resolutions were adopted:—

"*All communications to be made to persons or institutions not on the Committee in the name of the Committee are to be signed by the President and the Secretary.*

"*If it be necessary to discuss and decide a question by circular, the President shall fix a date for the replies, after the lapse of which he shall decide the question in accordance with the majority of the votes received. Upon the request of one of the members he shall submit the matter again to the judgment of the members of the Committee, and shall only decide the question after the receipt of fresh replies, which shall have arrived before a fixed date.*

"*The communications to be made to the Committee shall be addressed to the President or to the Secretary, who shall refer them to each other, and, in case of need, shall make them known to the members of the Committee by means of circulars.*"

It was agreed to publish the Report of the present meeting at Paris in the three languages as before.

To avoid any mistake a proof copy of the French edition of the protocols prepared by M. MASCART shall be addressed to the members of the Committee, who shall be requested to notify their corrections.

The PRESIDENT, in stating that all the questions of the Programme had been considered, declared the meeting closed, and requested M. MASCART to be good enough to convey to the French authorities the sincere thanks of the Committee for the cordial welcome which they had been kind enough to give it, and to accept himself the deep gratitude of all the members of the Committee for the interesting scientific enjoyments which he had procured for them during their leisure moments.

The meeting rose at noon, and the session was closed.

(Signed) H. WILD,
President.

APPENDIX.

APPENDIX I.

International Meteorological Committee Meeting at Paris, 1885.

Programme.

1°. Report of the Secretary upon the action of the Committee since the meeting at Copenhagen.

2°. Report of MM. de Brito Capello, Hildebrandsson, and Ley on the observation of cirrus clouds.

3°. Does it appear opportune to convene a Third International Congress at an early date?

4°. The establishment of stations of the First Order on the River Congo.

5°. Discussion upon the utility of the weather summaries published in different countries and eventful preparation of a more uniform plan.

6°. Discussion of the utility of the meteorological telegrams from America, proposed by General Hazen, and eventual organization of their distribution in Europe.

7°. How is it possible to ensure the receipt of meteorological telegrams in time to be of use.

8°. Should the reduction of barometric readings to the gravity of latitude 45°, be generally introduced?

9°. The method of the reduction of barometrical readings to the level of the sea, for synoptic charts. (Proposal made by General Hazen.)

10°. Is it desirable to reckon the hours of the day from 0h. to 23h. in meteorology also, in accordance with the resolutions of the International Conference at Washington?

11°. The designation of the form of clouds when the sky is entirely overcast.

12°. The determination of a zenithal zone for the estimation of the amount of cloud.

13°. The definition of days of rain and snow.

14°. Should not the general adoption of a uniform height above the ground for rain-gauges be recommended?

15°. What progress has been made recently for the more exact measurement of snow?

16°. The adoption of a standard anemometer for the determination of the velocity of the wind. (Proposal made by the Royal Meteorological Society.)

17°. The general adoption of a uniform height above the ground for anemometers. (Idem.)

18°. The International Meteorological Tables.

19°. Modification of the rules for the administration of the International Meteorological Committee.

Proposals made by the Deutsche Seewarte.

20°. A. Cannot the same time be adopted for all telegraphic observations taken in Europe, whether it be the same local time or simultaneous time. We should thus avoid the existing gaps of from 1–3 hours between

neighbouring stations on the two sides of frontiers which distort the synoptic charts of the respective countries.

B. How far could we provide for the possibility of filling up the meshes of the telegraphic reporting system, by the entry of at least a part of the observing hours for climatological stations and stations of the third order, for the purpose of special investigations. This would be of importance, especially for the warmer season in which thunderstorms generally occur.

21°. That the International Meteorological Committee should express its earnest wish for the publication of the observations from a number of stations—even if only from a limited number—in North and South America, in accordance with the International scheme.

That more attention should be paid to rainfall, &c. in the International forms of registers, and in the yearly summaries,—by entering the amount of the fall and the number of observations when it was raining or when snow was falling, for all observing hours,—the same as is done for other elements.

(Signed) H. Wild (President),
(,,) R. H. Scott (Secretary),
For the International Meteorological Committee.

APPENDIX II.

Report of the Secretary on the Action of the Committee since the Meeting at Copenhagen, 1882.

The Report of the meeting at Copenhagen has appeared in three languages; the English edition in 1883, the French and German editions subsequently.

The International Polar Committee held its fourth meeting at Vienna in April 1884.

At that time the different expeditions, with one exception (the Lady Franklin Bay expedition) had returned, and several gentlemen were invited to take part in the meetings as representatives of the majority of the expeditions, viz.:—

Captain Dawson, R.A. Fort Rae.
M. Nils Ekholm. Spitzbergen.
Dr. W. Giese. Kingawa, Cumberland Bay.
M. Edouard Payen. Orange Bay (Cape Horn).
Lieut. P. H. Ray, U.S. Army. Point Barrow.
M. Aksel Steen. Bossekop.
Lieut. von Wohlgemuth, I.A.N. Jan Mayen.

This conference discussed the question of the tables of observations and the form of publication of the results obtained, and adopted various resolutions upon this subject. It expressed the desire that the publications might be finished before the end of the year 1885.

The International Meteorological Committee decided to meet for the third time, on the 1st September at Paris, and the executive officers issued to meteorologists a circular together with a Programme of the questions to be discussed.

The Committee has received letters from General Hazen, the Royal Meteorological Society, &c., which are mentioned in the Programme, and also the following communications:—

(1.) M. Hellmann: On International Tables (Question 18) and on the measurement of rain in accordance with the method proposed by M. Köppen.
(2.) M. Capello: Replies to the questions contained in the Programme.
(3.) M. Mühry: On the importance of International observations around the Equator or Calm Belt.
(4.) The Italian Meteorological Society: On the measurement of snow.

(5.) Baron von Danckelmann: Remarks on the question of stations on the Congo.
(6.) Mr. Symons: Remarks on Questions 13-15 (the measurement of rain, &c.)
(7.) The Meteorological Office: Provisional report upon the service of telegrams from America.
(8.) MM. Hildebrandsson. Capello, and Ley: Report upon the question of cirrus observations.
(9.) M. Billwiller: Report upon the station on the Säntis.

M. Neumayer also wished to draw the attention of the Committee to the following points:—

(1.) The publication of observations made at some stations in North and South America.
(2.) The registration of the amount of rainfall at each hour of observation.
(3.) The adoption of the same hour for all observations sent by telegraph.
(4.) The possibility of filling up the gaps in the telegraphic system by the observations taken at climatological stations, &c.

(Signed) Robert H. Scott,
Secretary.

APPENDIX III.

Report to the International Meteorological Committee.

At the meeting of the Committee at Copenhagen in the month of August 1882, the undersigned, Hildebrandsson, was asked to take part in the deliberations upon the scheme for carrying on the observation of the clouds, proposed by him to the Committee in a paper dated May 25, 1878, and recommended by the International Congress at Rome.

At the same Conference, Mr. R. Scott said that on the suggestion of Mr. Clement Ley, observations of the cirrus for the forecast of daily weather had been tried in England since the year 1880.

After a lively discussion, M. Neumayer made the following proposal concerning the observations of the upper currents of the atmosphere.

I. A committee should be nominated, having for its object the preparation of simple instructions for the observation of clouds. These observations should be made at a certain number of suitable stations. Instructions should be limited to the following observations:—

(1.) The movement of the lower clouds.
(2.) The movement of the upper clouds or cirrus.
(3.) The radiation of the cirrus.

II. "The more detailed observations of the cirrus are strongly recommended by the Permanent Committee. However, at present, these observations ought to be entrusted to observers especially interested in these difficult studies. Above all, the nomenclature must be thoroughly fixed, and the phenomena to be observed must be strictly determined."

This proposal was unanimously adopted. Messrs. Brito Capello, Hildebrandsson, and Ley were elected members of the proposed committee.

This committee was charged in the first place with the preparation of Instructions for the simple observations more particularly described under 1. In the second place, it was also to take into consideration the detailed observations named under 2.

Mr. Clement Ley, after having been acquainted with the instructions given to the Committee, proposed to alter the plan of the Committee a little, because he himself was occupied upon similar work, the results of which might be of importance to the Committee. Also he has since published,

as is known, several papers, and some proposed instructions for the observations in view.

The Committee believes that it can at present carry out the first part of its instructions. It has, therefore, the honour of presenting the following instructions relating to the observations which should be carried on in each country. They are essentially in conformity with those proposed by Mr. Clement Ley.

It is sufficient for the observations actually in question to divide the clouds into two groups:—

A.—Upper Clouds or Cirri-form Clouds;
and
B.—Lower Clouds.

Whenever an observer is in doubt in which of the two categories he should place a cloud, it will be better to consider it as a lower cloud.*

For these observations the annexed formula has been drawn up:—

1. *Time of Observation.*—The first column contains the date; the second column the nearest hour to the time of observation. It is desirable that these observations should be made three times a day, when it is possible. To fix certain hours is not possible, but it is desirable that the observer should study the sky as often as his time permits him, and that he should take notes of all important phenomena, above all of all those that relate to the cirrus. The morning observations, local time, and those at mid-day (Greenwich time), are the most important for the synoptic charts.

2. *Movements of the Upper Clouds.*—The direction from which they come must be noticed. This often appears difficult on account of their ordinarily slow movement, but if the observer remains perfectly stationary for some seconds, he will easily observe their motion relatively to a steeple, a flag-staff, a ridge of a building, or something of the same kind. Above all the clouds which are nearest to the zenith should be noted as much as possible. It would be useful to erect a pole upon an open place, and so to station oneself that a distinct point of the cloud may appear to move from the summit of the pole in a direct line towards the observer, or in the opposite direction. If the observations are made at a window, it is convenient to stretch across the window some horizontal or vertical threads, crossing each other at right angles, or better still, to trace marking lines upon the window-panes. In order to avoid mistakes, it is necessary, especially if the movement of the clouds is very slow, to rest the head for support against a wall or upon the hand, if the arm has a firm support. When there are no clouds near the zenith, the observations are more difficult, because perspective is apt to cause some errors. For the avoidance of these errors, experience is necessary, that is to say, the observer should compare the movement of one part of a cloud near the zenith with those of other parts in the same stratum of clouds, situated at different elevations above the horizon, and in different directions. It is safest to observe a part which moves straight towards the observer, or in an opposite direction. It is however desirable that some simple nephoscopes should be provided, so that greater exactitude may be attained. M. Marié Davy's instrument, used at the Observatory of Montsouris, and that of M. C. Fornioni, are especially simple and suitable.

3. *Velocity of the Upper Clouds.*—These clouds are rarely quite motionless, but owing to their great distance, they ordinarily seem to move very slowly, and generally, but not always, less rapidly than the lower clouds. Their velocity, estimated by sight, is indicated by the following numbers:—

0 = Absence of motion;
1 = Very slight motion;
2 = Ordinary motion;
3 = Rapid motion;
4 = Extremely rapid motion.

* The white clouds in the form of balls of cotton, called "cirro-cumulus" or "alto-cumulus," are ranged among *lower clouds*.

We here encounter the same difficulties as in determining the direction of these clouds. Their apparent velocity depends not only upon their height above the horizon, but also on their direction with reference to the observer. In general the velocity should not be determined, except when the cloud is near the zenith; it needs much practice to be able to determine with any exactitude the velocity of clouds near the horizon. We may erect a pole for the determination of the direction of clouds, which can also be employed to estimate their velocity with much accuracy. For this object a mark must be made, for example a coloured ring, at the elevation of the eye, and at 1·7 m. (5 feet 7¼ inches), above this a horizontal cross must be placed indicating the cardinal points. Next, there must be attached to this cross a ring of metal wire of 0·9 m. (3 feet) in diameter, so that the pole passes through the centre. If the eye be placed at the lower mark, the ring will be about 15° from the zenith. In observing the time occupied by the passage of a certain part of a cloud from the summit of the pole to the ring, we have a velocity of 1, if the time is more than 10 minutes; 2, if the time is between 5 and 10 minutes; 3, if the time is below 5 minutes; and 4, if the time is less than 1 minute. In the employment of a nephoscope of the mirror type, we can trace around its centre a circle, of which the radius corresponds to a motion of 15°, or else we may trace two concentric circles in such a way that the image of a cloud near the zenith shall take the same time in passing from one to the other of these circles, as the cloud itself takes in traversing 15° from the zenith.

4. *Point of radiation.*—Cirrus is often visible under the form of thin parallel bands, appearing to issue, on account of perspective, from a point on the horizon; sometimes traverse all the sky, and have these bands two points of radiation, situated 180° one from the other. These forms of cloud, which play an important part in the popular forecasts of the weather in nearly every country, are sometimes called "polar bands," sometimes "Noah's arks," sometimes "roots of the wind," &c. At the meeting of the Committee at Copenhagen, in accordance with the proposal of M. Mascart, the simple denomination of "*Radiation of cirrus*" has been adopted. The points of radiation are also easy to discover, when the clouds do not reach as far as the horizon. The simplest manner is to turn as if we wished to pass under the highest part of such a band, or of its prolongation. The points of radiation are then at the right and left hand, or at 90° from the point of the horizon towards which we have turned. Of the two points of opposite radiation, we note down that which is the nearest to the quarter from whence the clouds move. If the clouds come *e.g.*, from the W., and the bands are lying in the direction S.W.—N.E., it is S.W. which is the point of radiation. If the motion of the clouds be imperceptible, or if they move at a right angle to the direction in which the bands stretch, which rarely happens, both points of the horizon in question should be noted down.

5. *Density and position of the cirrus bank.*—The upper clouds often take the form of a canopy, or veil, of more or less density, which, lying above the horizon, is similar to a thin bank, and is light, or greyish. It is in this veil that halos and coronæ of the sun and moon frequently appear, parhelia, and paraselenæ. As this form of cloud is intimately related to barometric depressions, it is important to notice it.

(a.) *The density.*—0=very thin and ill-defined; 1=thin, but definitely formed; 2=rather heavy; 3=heavy; 4=very heavy and of a deep colour.

(b.) *Position*, or direction, in which the veil, or bank, appears the thickest.

6. *Motion and velocity of the lower clouds.*—As the lowest clouds often appear simultaneously with the upper clouds, their movement and velocity must be equally noticed, particularly on such occasions. We can determine them in the same way as the cirrus, but the observations are easier, these clouds being much nearer the observer than the upper clouds. Their apparent velocity being on the average, much greater than that of

cirrus is estimated at 0=no motion, 1=slow, 2=moderately quick, 3= quick, 4=very quick ; that is to say according to the scale for a long time in use for the observation of storms in France, Scandinavia, and other countries also.

VII.

The direction and velocity of the wind are determined in the same way as usual.

VIII.

The observers are requested never to enter an observation which is not certain.

The observations here proposed are, as we have already said, but very simple ones, which can be easily carried out in every civilised country, and almost by anyone, provided a little pains is taken with them. We know also by experience that it is not difficult to find persons disposed to undertake such work and capable of executing it in a satisfactory manner. Take, for instance, the series of observations, embracing a great number of consecutive years, which have been carried on in many countries, notably in England and Sweden. More detailed observations will some day be carried on, with still more important results. Much, however, has already been gained, if at a great number of stations situated in every country of the world, we can make numerous observations upon the direction of the wind, at three different heights above the surface of the earth.

Even at sea we ought to make regular observations of this kind, which would evidently be of very great utility. Hitherto we have, with reason, regarded the observations made upon the movements of the clouds on board ship as very difficult. Such observations also are very rare. However, it ought not to be difficult to conduct them with the help of suitable nephoscopes. The meteorologists who took part in the expedition round the world of the Swedish frigate "Vanadis" in 1883-85 were provided with a nephoscope (on the model of M. Fornioni) suspended like a compass. It is desirable that such experiments should be made in the navies of all countries. When it is difficult or impossible to ascertain the movement or velocity of the cirrus at sea, the radiation can in many cases be easily observed, and this, even by itself, it is important to register.

In England experiments have been made during the last few years of introducing cirrus observations into telegraphic meteorology. It appears that such a system would be of great importance to the forecasts of weather. We invite the directors of all the Central Meteorological Offices to follow the example set by England. It does not seem possible at present to give definite instructions. We must at first follow the method adopted in England; we shall be able, in case of need, to modify it later according to practical exigencies.

With regard to *detailed observations upon cirrus*, and a new cloud classification, it appears to us that definite instructions ought not as yet to be given. It is first necessary for this purpose that special research should be made. We can but invite all who are interested in these observations to work with us at the solution of these interesting problems, which will doubtless be of the utmost importance to the whole science of meteorology. It will be of especial importance for a new cloud classification to have good representations by photography, or lithography, of the forms most prevalent in each country. For our part, we shall not only pursue these researches, but we shall pay attention to all that is done by other meteorologists, and as soon as results have been obtained which appear likely to lead to the introduction of new observations in each country, or at least at the principal stations, we shall not be slow to insist upon a similar plan.

Publication of the proposed observations.—Lastly, with respect to the publication of the observations here proposed, we should wish to publish them *in extenso* in every country, at the end of the Annual Reports

published by the Institutes or Central Offices. The number of the observations taken at each station differ considerably in different countries, as much on account of the varying zeal of the observers, as of the differences in the general meteorological conditions of each country. At Upsala, the progress or radiation of cirrus has been capable of being observed on 125 days during the year 1883.

(Signed) J. C. de Brito Capello.
H. Hildebrand Hildebrandsson.
August 17th, 1885. W. Clement Ley.

Recommendation.

For this reason we would propose to establish at each Meteorological Observatory of the First Order a system of *three* stations, all in telephonic connection with each other, one of which should be at a considerable distance from the other two, say three miles [5,000 metres]. By this means we should obtain a suitable base for cirrus observations. The two other stations should be placed at a distance of 500 or 1,000 yards [metres] apart, to serve as a base for the observation of the lower clouds.

APPENDIX IV.

Report by Capt. J. C. de Brito-Capello on the Establishment of Meteorological Stations on the Congo.

Since June 1883 we have established a Meteorological Station of the Second Order at San Salvador on the Congo, Lat. 6° 17′ S., Long. 14° 53′ E. Altitude 569 metres. The observers are the clergy of the Portuguese Mission to the Congo. They take observations four times a day, and synchronous observations at 0h. Greenwich time, and they display much zeal and bestow much care on their work.

After the Conference at Berlin with reference to the Congo, we have studied the question, and have proposed a station on the seacoast, and a little later on we shall establish a new station at Cabinda or at Landana.

These two stations are on the seacoast, and the former one at San Salvador will be raised to a station of the First Order, and be furnished with self-recording instruments for pressure, temperature, and wind direction and velocity, that is to say, with instruments similar to those at the observatory of Loanda.

For pressure and temperature, Richard's self-recording instruments are used, which give very satisfactory results, when used by experienced observers.

For wind, direction, and velocity we employ a portable anemograph, which leaves nothing to be desired; its weight does not exceed 18 kilogrammes, and its dimensions are very small [a photograph of the instrument accompanied the letter]. The direction and velocity can be recorded on forms, corresponding to two or four days, as required for each turn of the cylinder.

The instruments for the stations in the interior must be light, because the "carregadores," negro porters, do not generally carry more than 25 kilogrammes on their backs.

The stations of Cabinda and Landana, with that of Loanda, give us the elements for the seacoast, and these can be compared with those of San Salvador, and with those of other stations at selected places on the Upper Congo. Such observations will be most interesting and of great scientific value. It seems to me to be essential to use self-recording instruments.

Observatory, Lisbon,
July 1, 1885.

APPENDIX V.

Report on the Establishment of Meteorological Stations of the First Order on the Congo; by Baron A. von Danckelman. (From "Ciel et Terre," July 15, 1885.)

Among the questions for discussion by the International Meteorological Committee at the meeting to be held in Paris in the beginning of September 1885, No. 4 of the Programme there is one that deeply interests geographers and meteorologists, at least those who are concerned in the development of our knowledge of Africa; viz., the establishment of meteorological Stations of the First Order on the River Congo.

This question has already occupied the attention of the Berlin Conference. The Russian Government, which possesses such a perfect network of meteorological stations on her own territory, and which every year spends thousands of roubles on their maintenance and extension, has always shown itself to be the zealous protector of Meteorology. It again, through the medium of its representative at the Conference, Baron Kapnist, has called attention to the importance of the question, and to the necessity for the establishment of such stations.

As far as concerns meteorology and physical geography, the benefit which would be derived from these stations would obviously be invaluable, and the debated question of the colonization of tropical Africa might be discussed from the standpoint of actual information, which at present is entirely wanting. The question possesses, therefore, here a practical side of great importance.

With the exception of the missions of Rubaga, on the Victoria Nyanza, and of Lado, on the Nile, the interior of tropical Africa has not hitherto furnished any series of observations of any value. The climatic data scattered over the narrative of travels such as those of Stanley and Johnston are too vague, and are not sufficiently precise to be accepted as conclusive results. It must also be borne in mind that most of these observations have been made with instruments very frequently imperfect, and which scarcely ever have been subjected to any preliminary comparison. Such observations, therefore, cannot lay claim to any great scientific value.

It may be inferred from this that those who urge the colonization of the interior of Africa, its agriculture and its forests, must consider the establishment of meteorological stations as a duty, and must insist upon this point, for these stations will be particularly appropriate for the objects they have in view.

The knowledge of the climatic conditions of the regions of the Upper Congo, acquired by carefully-made meteorological observations, would undoubtedly be of essential utility, from an economic point of view, such as cultivation and plantations. The organization of meteorological systems at great expense by the English in India, and in Barbadoes for instance, has certainly not been due to theoretical reasons solely.

The International Meteorological Committee have been induced by purely scientific motives to consider this question. Accordingly, the stations should be of the First Order, that is, they should possess self-registering instruments, viz., a barometer, a thermometer, and an anemometer, giving continuous observations, such as could not be expected from a station of the Second Order.

We recall to mind the first Meteorological Congress held at Vienna in 1873, which had such a notable influence on the uniform and systematic organization of observations over the surface of the globe. At that time, the Fourth Sub-Committee, appointed to study the question of hours of observation, strongly recommended the establishment of hourly observations at certain specified places in India, Australia, and Brazil, in order to determine the march of temperature in the tropics. Central Africa was not even thought of, as a mysterious veil still covered all parts of it. We see that in 12 years things have greatly changed, the centre of Africa is now relatively easily accessible; a great number of stations already exist

along the upper course of the Congo. But unfortunately, hitherto, they have done nothing for science. How can we help recalling to mind the lofty and almost ideal projects of the African Conference held in the Palace of Brussels in 1876, which were unanimously applauded by the scientific world? It was stated publicly that the stations would have, first of all, a scientific object, and meteorological observations were even specified. At the present time we do not possess a complete series of observations for any one point along the middle or upper course of the Congo. Nothing has yet been done in this direction, and yet what important and evident results has not meteorology to expect from even a partial realization of the fine projects that had been cherished.

We must admit that we know scarcely anything of the march of air-temperature in the interior of tropical continents, or of the daily variations of the barometer, of relative humidity, of the direction and force of the wind, of the frequency of rainfall, &c. Any of us who have undertaken to reduce the observations of African travellers for the purpose of determining the altitude, whether the barometric, or the hypsometric observations, will understand the difficulty of obtaining even somewhat reliable results. Even supposing that the observations themselves have been made with accurate instruments, the lack of materials prevents us from eliminating various causes of error, such as, for instance, the diurnal or annual range of pressure. The more Africa becomes known and explored by travellers, the more imperiously will the necessity be felt for the establishment of certain fixed points, which will allow us to connect the labours of these explorers with each other.

And what should these fixed points be, but Meteorological Stations of the First Order, the results of which would serve as the basis for a serious reduction and comparison of all other observations? Thus a single station established at Banana, Boma, or Vivi, or even at Stanley Pool, would allow of the exact determination of all the observations of altitude made in Western and Central Africa.

From a purely practical point of view, stations of the First Order are compulsory. The conditions of the existence of the eye-observers are too liable to changes to permit them to obtain an uninterrupted series of observations. Sometimes they are attacked by fever, sometimes they are exposed to the ill-will of the natives, or have to make short journeys in the neighbourhood of the stations. Hourly observations are quite out of the question; the staff would not be sufficient for this, and in the tropics sleep, which is very necessary, cannot be dispensed with. Simple registering instruments, which only require to be looked at once a day, or once a week, are not subject to all these drawbacks. The instruments do not catch fever, nor require sleep, they make no mistakes, nor do they write badly, as a careless observer might.

We need not here raise the question "how" this enterprise should be carried out. That should be, in our opinion, the task of a special committee, which would endeavour before all things to put itself in communication with those who are disposed to favour the establishment of these stations, and who might provide the funds, which, however moderate in amount, are indispensable. This committee would have, moreover, to settle all questions of detail concerning the choice of stations, of instruments (which should be of the simplest patterns), and, finally, of the persons destined to superintend these scientific establishments.

We will only add another word upon this subject. It is above all necessary to guard against asking for too much. Here, again, we should leave well alone. The establishment of one station on the coast, or in its vicinity, is, in our opinion, absolutely necessary for the study of the laws of lower strata of the atmospheric movements, and one or two other stations on the upper course of the Congo would be an immense gain, for which geographers and meteorologists would be ever grateful to those who would further this noble enterprise by pecuniary resources, and by intellectual and moral efforts.

APPENDIX VI.

Proposal by Dr. A. Mühry respecting International Observations along the Equator or Calm-belt.

The author proposes that the International Meteorological Committee should express their opinion that it is at least desirable, and even to a certain extent requisite, that synchronous physical observations should be taken for a year at stations situated near the Equator or in the Calm-belt. These observations should be organized on a common international and scientific plan, as complementary to the physical observations undertaken at 14 stations in the Polar Regions in the year 1882–3.

He ventures humbly to suggest a list of 16 stations which appear to be suitable for the purpose. These are as near as possible in 1° North Latitude, and arranged from west to east:—

South America:—
Esmeralda, Antisana (4,000 m. high), a station on the Rio Negro, Macafa.

South Africa:—
St. Thomas, The Gaboon, a station on the Congo, Kenia Mountain (4,000 m. high), Brava.

Malay Archipelago:—
Sumatra, Singapore, Borneo, Ternate.

Pacific Ocean:—
The Gilbert Islands, the Baker Islands, the Galápagos Islands.

Göttingen, July 1885.

APPENDIX VII.

Report by Dr. R. Billwiller on the Establishment of the Meteorological Station on the Säntis.

This station has been for the most part established and maintained by private funds, but from the beginning of September 1885, after a temporary maintenance of three years, and therefore at the period of the meeting of the International Meteorological Committee in Paris, it will be taken over by the Confederation. (Message of the Federal Council to the Federal Assembly dated 6th March 1885 and Federal decree dated 15th July 1885 [not printed here]). Switzerland has thereby completed as far as was possible, the task laid down in Art. 30, Resolution C., of the Programme of the second Meteorological Congress at Rome. Once the maintenance of the station is secured, it will not be very difficult to establish a special small observatory there, such as is indispensable for certain observations, viz., magnetic observations, and observations of atmospheric electricity, which are yet to be introduced. As there is at the present time a general disinclination to the convening of a fresh Meteorological Congress, I may perhaps be allowed, upon this occasion, to point out that, on the other hand, it should not be overlooked, that the authority of such a Congress is indispensable in order to carry out certain schemes. Even if all the decisions of a Congress cannot be fulfilled, yet certain matters of detail are greatly promoted by it. I must admit that owing to the many difficulties which were opposed to the erection of a station upon

the Säntis, this undertaking could scarcely have been carried out had I not been supported by the authority of the Congress at Rome.—Schweizerische Meteorologische Central Anstalt, Zürich, 25th August 1885.

[With this report, Dr. Billwiller forwarded a copy of a report on the Establishment of the Station on the Säntis, and on its operations from 1st September 1882 to the end of August 1884. "*Bericht über die Errichtung der Meteorologischen Station auf dem Säntis, &c.* 8°. 20 pp. Zürich, 1884.]

APPENDIX VIII.

REMARKS by CAPTAIN J. C. DE BRITO CAPELLO on the STEPS to be taken to ENSURE the RECEIPT of METEOROLOGICAL TELEGRAMS in TIME to be of USE.

Of late the map in the Paris Meteorological Bulletin rarely contains the observations of the Portuguese stations; the Spanish observations are also very often missing.*

I have endeavoured to find out the cause of these failures, and after considerable correspondence, I have come to the conclusion that they are very complicated, and very difficult, or even impossible, to be remedied at once.

In order to ensure completely the international transmission of the meteorological reports, there should be a complete system of meteorological telegraphy, that is to say, the meteorological observatories or institutes must be in direct telegraphic communication, by means of underground lines.

Such a system is very far from being realized. Nevertheless, we ought to try to improve the existing service, although its imperfection is well known.

At present, meteorological reports are transmitted over lines called international, by the telegraphic administrations of neighbouring countries, the reports being classed as "Service telegrams" (A).

Telegraphic reports are classified under three heads:—

1°. State telegrams (S); 2°. Service messages (A); 3° Private telegrams (P). The transmission of the telegrams of these three categories takes place in this same order; the State telegrams (S) precede all others in the order of transmission.

The category (A) of meteorological telegrams is therefore one of the causes of delay. In fact, when the service telegrams of the telegraphic administrations and other sources are numerous, during the morning hours, the time when the meteorological reports are sent, the latter will be detained until all the others of the same category and of the higher category (S) have been forwarded.

It will naturally be imagined that the way of remedying or removing this cause of delay would be by raising the meteorological reports to the first class (S) State telegrams. For these latter messages are neither very numerous, nor are they generally transmitted during the early hours of the morning. The delays arising from this cause would be thus reduced to a minimum.

Would it be possible to make this change with regard to meteorological telegrams?

* During the six months, July to December 1884, the reports from Lisbon only arrived four times early enough to be included in the chart; they arrived too late for the chart, but early enough for insertion in the Bulletin 77 times, and too late for either on 103 occasions.

At the first glance we do not see any serious objections to this measure. In fact, no increase in the transmission would result from this change—a class of telegrams which appears to be over-burdened would be relieved.

At all events this new classification of meteorological telegrams should be proposed and submitted for the approval of a telegraphic congress.*

Another cause of delay in transmission is the derangement of over-ground wires, owing to the fall of posts, brought about by either strong winds, snow, or thunderstorms, &c.; this cause is most serious for daily meteorological investigations, for it happens just when the telegrams are most necessary. There is only one effective remedy for obviating these vexatious interruptions, viz., to lay the wires underground.

The construction of underground lines is now an accomplished fact, it is only a question of money. As a rule, all international lines should be underground. That is therefore a question that Governments might solve, and is a matter of time, for it will be solved sooner or later. Demands should be made with this object, and should first be made by commercial men, for commerce is equally interested with meteorology in this subject.

It is true that as regards Portugal there is a submarine cable from Lisbon to Falmouth, which might be employed in the transmission of meteorological reports for the central office in Paris, and *vice versa*, in case of the interruption of the land lines; but it must be admitted that this measure, independently of the expense that would be incurred, would be a very precarious and uncertain remedy. In fact, the meteorological telegram being in this case a private message, it would have to be forwarded in the order in which it was handed in, and as the cable would be encumbered with telegrams, owing to the interruption of the land lines, we can guess what the delay would be, and which would be further increased by that of the transit from Falmouth to Paris.

We might mention many other causes of delay, for instance the time taken in the transmission between the observatory or central, and the principal station, the want of sufficient clerks, their zeal, &c.

There is still another well known cause of delay for all eastern countries, which receive messages from western countries, and, on the contrary the acceleration of time for western countries, which receive messages from countries to the east of them, viz., the difference of longitude. We might meet this cause of delay by taking the observations earlier in western countries. The idea of synchronous observations naturally comes in here, but this question has been the subject of another proposal at the Copenhagen Meeting.

To resume,—I think this sorry condition of telegraphic transmission might be remedied by carrying out the following two measures:—

1°. By raising the class of meteorological telegrams to that of state telegrams.

2°. By laying the international lines underground.

We must therefore solicit, by all means within our reach, the carrying out of these two measures, by agreement between the Governments, or by proposals to, and approval by the next Telegraphic Congress.

Observatory, Lisbon,
July 1, 1885.

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* The Portuguese delegate to the present Telegraphic Congress at Berlin has made a proposal to this effect.

APPENDIX IX.

Proposal relative to the Method of Transmitting Meteorological Telegrams from America by M. Leon Teisserenc de Bort.

The utility of daily telegrams showing the condition of the weather over North America is evident from the interdependence of the movements of the atmosphere in different places. This connection is intensified by the somewhat frequent translation of depressions from America to the north of Europe.

And the movements of the atmosphere over North America, when compared with our European observations, allow of our forecasting, to a certain degree, what is taking place over the ocean, especially the changes of position of the large areas of barometric maxima and minima.

The late Captain Hoffmeyer, in his interesting work on the Movements of the Atmosphere over the Ocean, has included America in the system which he considered useful for improving weather predictions in Europe.

M. Rollin, also, has pointed out in the *Annales du Bureau Central Météorologique de France* (Vol. I., 1881), the advantage that may be derived in forecasting weather from the simultaneous knowledge of reports from Europe, Siberia, and the United States.

In order to hasten the practical solution of this question, we must find a simple and inexpensive plan for transmitting by telegraph the principal particulars of the state of the weather in America.

I propose to do this in the following manner:—

Meteorologists are, I believe, agreed that what we want to know is the general trend of the isobars in America, together with the salient features of the weather,—not the details of the distribution of pressure, the small inflexions of the curves, and the local phenomena.

We must, therefore, know first of all what type of isobar prevails in America. Now the systematic study of American weather charts shows that these types are scarcely 20 in number. These may be denoted in the following manner, by characterising them according to the position of the areas of high pressure which is tolerably stable. (1.) Types with barometric maximum to the west, and variations. (2.) Types with maximum to the south, and variations. (3.) Types with maximum to the east, and variations. (4.) Types with maximum to the north, and variations. (5.) Types with maximum in the centre, and variations.

By denoting each of these types and its variations by a letter, we have a simple mode of transmitting the chart of isobars in its main features.

Secondly, as the general distribution of the isobars may leave some points in uncertainty, we must know the barometric extremes shown upon the chart, in addition to the general form of the isobars. For that purpose the value of the principal barometric maximum is given by a letter, and its position when there are two maxima, which frequently occur, is also indicated by a letter, which corresponds to the position of the centre of high pressure, the chart of America being divided like a chess-board, each square of which bears one of the 26 letters of the alphabet.

In this way a first group of three letters is formed:—

B N D.

The first letter, B, denotes the type of isobars at the time of observation.

The second letter, N, shows that the centre of the principal maximum is in the region N, which corresponds to Arizona.

The third letter, D, tells us that the pressure at the centre, according to the conventional table, is 767 mm.

The position of the minimum pressures is not less important.

We generally find two centres of low pressure, one, for instance, over the region bordering on the Pacific, the other over the basin of the great lakes, and we ought also to receive information about these two centres.

The low pressures that are most distant from the Atlantic, or rather from Europe, interest us only in so far as regards the disposition of the isobars over America. The minimum which is nearest to us, on the contrary, not only forms a part of the chart of America, but by its movement towards the east, it may at any moment influence the distribution of pressure over the ocean, and affect the weather in Europe; sometimes it may even find a place in our daily charts. It is evidently this minimum to which we should turn our attention.

The position of the minimum that is most distant from Europe is indicated by a letter denoting the region; the pressure at the centre is also indicated by a letter. These form the first two symbols of the second word, or group of three letters. The third denotes the latitude of the minimum nearest Europe. Thus in the second word,

M R I,

M denotes that the minimum which is most distant from us is near San Francisco.

R denotes that the pressure in the centre of the minimum according to Table II. is 752.

I indicates that the minimum which is nearest to us is in latitude 45°.

The longitude of this minimum is indicated by the first letter of the third group.

The value of the pressure in this minimum is indicated by the second letter of the third word.

The third letter denotes the force of wind in this depression.

If it be thought desirable a fourth word could be sent, the first letter of which would indicate the direction in which the depression has advanced since the last observation eight hours previously; the second, the velocity of translation in the eight hours; the third, the increase or diminution of pressure at the centre during the eight hours.

Thus, with four groups of three letters, we could transmit the conditions of the weather, together with details of the movement and intensity of the depression which is nearest our coasts, in other words all that is of interest.

The cost for that would be:—

Four words at 2*s*. and one for the address = 10*s*.

Or for the year, 10 × 365 = 182*l*. 10*s*. 0*d*.

Fig. I.

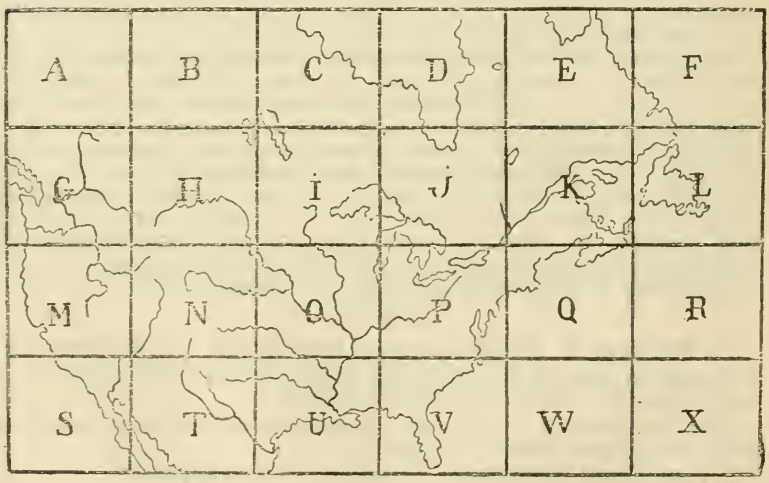
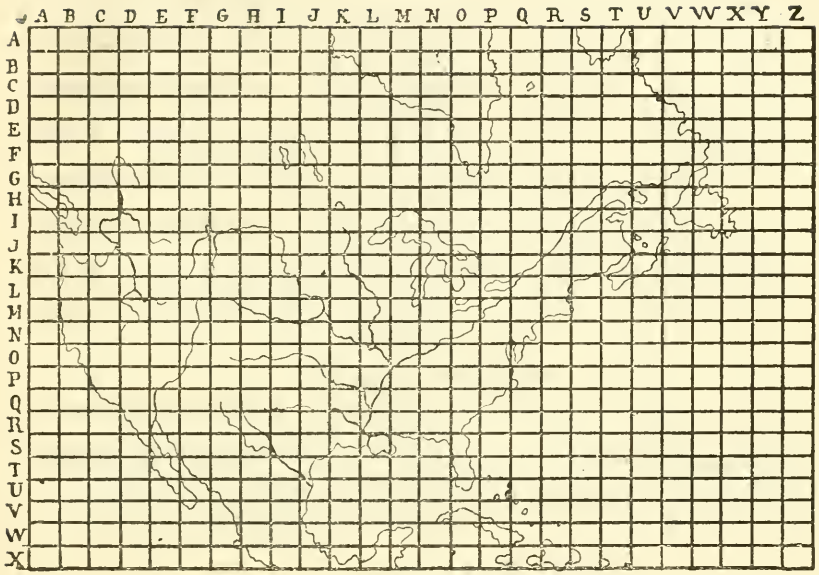


Fig. II.



LETTERS.	3. Col. I. Barometric Heights in the Maximum.	5 and 8. Col. II. Barometric Heights in the Minima.	9. Col. III. Velocity of Wind in Metres per Second.	10. Col. IV. Direction towards which the Depression advanced during the 8 Hours.	11. Col. V. Rate of Translation of the Minimum in Kilometres per Hour since the previous Observation.	12. Col. VI. Change of Pressure at the Centre of the Minimum during the last 8 Hours.
A	764	718	6	N.	0	−24
B	65	20	7	N. 15 E.	2	−22
C	66	22	8	N. 30 E.	4	−20
D	67	24	9	N. 45 E.	6	−18
E	68	26	10	N. 60 E.	8	−16
F	69	28	11	N. 75 E.	10	−14
G	770	730	12	E.	12	−12
H	71	32	13	E. 15 S.	14	−10
I	72	34	14	E. 30 S.	16	− 8
J	73	36	15	E. 45 S.	18	− 6
K	74	38	16	E. 60 S.	20	− 4
L	75	740	17	E. 75 S.	22	− 2
M	76	42	18	S.	24	0
N	77	44	20	S. 15 W.	26	+ 2
O	78	46	22	S. 30 W.	28	+ 4
P	79	48	24	S. 45 W.	30	+ 6
Q	780	750	26	S. 60 W.	32	+ 8
R	81	52	28	S. 75 W.	34	+10
S	82	54	30	W.	36	+12
T	83	56	32	W. 15 N.	38	+14
U	84	58	34	W. 30 N.	40	+16
V	85	760	36	W. 45 N.	42	+18
W	86	62	38	W. 60 N.	44	+20
X	87	—	40	W. 75 N.	46	+22
Y	88	—	42	—	48	+24
Z	89	—	44	—	50	+26

General List of the Symbols.

1st word	Letter 1	denotes	the type. (See the types of Charts, Figs. III. and IV., p. 34.)
	,, 2	,,	the region occupied by the centre of the maximum. (See Fig. I.)
	,, 3	,,	the pressure at the centre of the maximum. (See Col. I.)
2nd word	,, 4	,,	the position of the most western minimum. (See Fig. I.)
	,, 5	,,	the value of the barometric pressure in this minimum. (See Col. II.)
	,, 6	,,	the latitude of the most eastern minimum. (See Fig. II.)
3rd word	,, 7	,,	the longitude of the most eastern minimum. (See Fig. II.)
	,, 8	,,	the value of the barometric pressure in this minimum. (See Col. II.)
	,, 9	,,	the wind force in this minimum. (See Col. III.)

Fourth Word, Optional.

4th word	,, 10	,,	the direction in which this minimum is moving. (See Col. IV.)
	,, 11	,,	the velocity of translation since the last observation. (See Col. V.)
	,, 12	,,	the last change of pressure at the centre in 8 hours. (See Col. VI.)

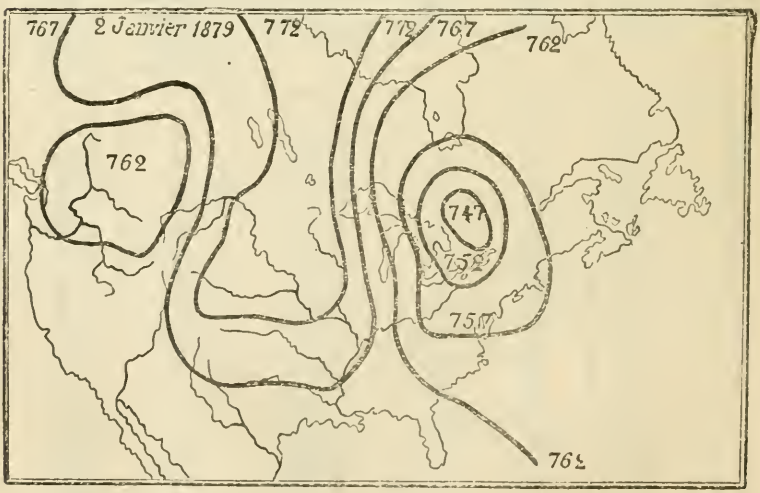
Example.

Let us take for example the charts of the 2nd and 3rd January 1879, which belong to the same type, with some small variations.

The chart for the 2nd belongs to type **o**, and its telegraphic code would be—

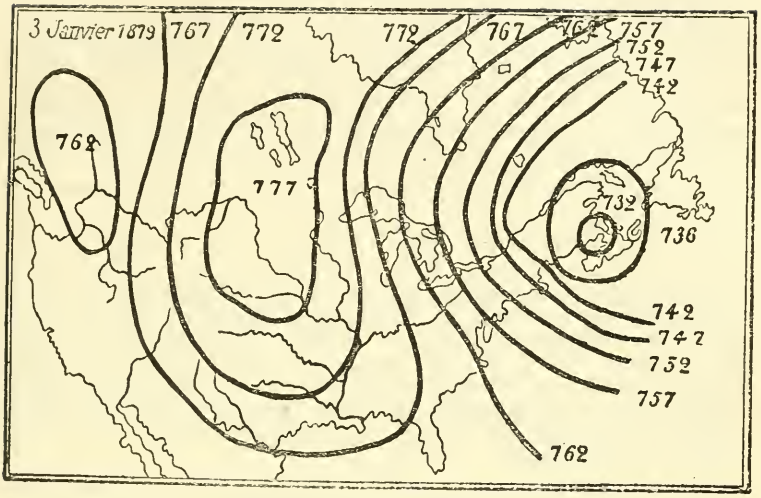
oin gwj qpg.

Fig. III.



The chart for the 3rd belongs to the same type, but while the disposition of the isobars has remained nearly the same at the centre and to the west, the easternmost minimum has deepened and has advanced eastwards.

Fig. IV.



In the telegraphic code, the first part, relating to the type, to the position of the maximum, its pressure, and to the position and pressure of the most western minimum remains the same; the second part, relating to the eastern minimum, is modified as shown by the chart for the 3rd. We shall have therefore—

oin gwi uhn hvj.

Meaning of the Telegram.

o Type with maximum in the centre of the United States, minima to the west and to the east.
i The principal maximum is situated in region I. (Minnesota).
n The pressure at the centre of the maximum is 777.
g The most western barometric minimum is in region G on the coast of the Pacific.
w The pressure at the centre there is 762.
i The most eastern minimum is in lat. 45°.
u The minimum nearest Europe is in the long. of Nova Scotia.
h The pressure at the centre there is 732.
n The velocity of the wind there reaches 20 metres per second.
h In the last eight hours this minimum has advanced towards E. 15° S.
v The velocity of translation of the centre of the minimum is 42 kilometres per hour.
j Pressure has fallen at the centre 6 mm. in eight hours.

APPENDIX X.

Signal Office, War Department,
Washington City, May 27, 1885.

Sir,

In the matter of the reduction of the barometer to sea-level, I beg to submit the following considerations and to ask your kindly criticism and remarks.

It would seem that the combination of observations on land with those on vessels, as long ago as 1857, rendered it necessary to give up the isabnormal lines (the isobarometric of Kämtz), and reduce all pressures

to sea-level, and draw isobars which extended without serious error over low-lying portions of Europe and the adjoining ocean.

The Signal Service in 1870, for the first time, had to confront the problem of drawing isobars on tri-daily maps (morning, afternoon, and midnight), not only over oceans and lowlands, but inwards over high plateaus.

In 1870 and 1871, this service endeavoured to reduce each barometric observation to sea-level, by considering only the temperature and pressure prevailing at the station at the moment of observation, and by assuming the average temperature of the column of air imagined below the station to be represented by the formula $t_0 = t_1 + \frac{h}{2c}$, where t_1, is the observed temperature, and $\frac{h}{2c}$ the variation due to altitude. In any formula of this kind it is evident that by using t_1, there is a diurnal period introduced into the reduced barometer, which for high stations is very large and misleading. So troublesome was this, that already in January 1872 this method was discontinued for the very highest stations (see Annual Report Chief Signal Officer, 1873, p. 373), and an annual constant was used for these, in order at least to be able to follow the local tri-daily changes in pressure.

But for stations from 2,000 to 5,000 feet high, the original method still gave the same trouble, which was aggravated by a serious mistake in the use of a certain formula.

In 1881, this office began using for all station, a system of monthly constant reductions to sea-level based on the monthly normal pressures and temperatures. (See Annual Report, 1882, pp. 826–846.) This method was adopted as a temporary device, and especially for certain financial reasons; it has features confessedly quite as objectionable as either of the above-mentioned methods.

The arguments against any reduction of high stations to sea-level, and in favour of adopting a high plane, say 5,000 feet, to which both high and low stations should be reduced, are fully appreciated. They were, in fact, urged upon the attention of General Myer as early as 1872. This idea has been exemplified in the work of several European meteorologists, but as the reduction *to sea-level* still continues the most popular, improvements in its details have been constantly kept in view.

An important modification is now proposed, which, while considered to have decided advantages, yet introduces so great a departure from existing customs, that, before adopting it, I desire a free expression of your own views as to its merits and defects, as I should prefer to make changes only in the direction of some method that would be generally acceptable to all meteorologists who have to prepare daily weather maps from telegraphic observations.

It is proposed to utilize the fact demonstrated by several, notably Rühlmann, that the regular periodic diurnal change of temperature of the *mass of air* above or below any station, is so small as to be negligible in comparison with the periodic change at the station itself, and especially in comparison with the non-periodic changes that accompany the vertical and horizontal movements of large portions of the atmosphere. It follows from this, that the reduction to sea-level should be but little affected by diurnal temperature changes at the stations, but should depend principally upon the mean temperature of the air, whether the latter be a quiescent layer or a current flowing rapidly past the station. It is, therefore, necessary to devise such a combination of the local observations as will follow closely the large non-periodic changes of temperature, while at the same time eliminating the greater part of the periodic diurnal fluctuations shown by the station thermometers, and which are generally very local phenomena. It is not clear that we should attempt wholly to eliminate the diurnal fluctuations, as there must be a small period in the daily temperature of the mass of air, but, for the present, we may neglect this refinement.

The special method by which the observer at any station may most easily obtain the mean temperature to be used in reducing the barometric observation, which he is then about to telegraph to the central station,

must be left to the discretion of the respective national weather bureaus. It is sufficient to recognise the principle that he must use a temperature from which the diurnal periodicity has been largely eliminated.

The following examples are suggested:—

For the tri-daily observations and reports of the United States, use the mean of the temperatures observed at the given hour and the two preceding observations.

In such a combination the diurnal variation is approximately eliminated, and the means follow the gradual non-periodic changes with considerable closeness. Thus, in the accompanying chart of isobars for 7 a.m., February 4, 1883, Springfield, Ill., is in the front of an advancing mass of cold, dry, air.

Now if we examine the record at this station, we find the temperature as given in the second column of the following table; in the third column is given, opposite each hour of observation, the mean of its own and the two preceding figures.

These latter are seen to follow the gradual diminution of temperature and to be freed from diurnal change. They indicate approximately, therefore, the current temperature of the mass of air beyond the diurnal changes determined by the surface of the earth.

Springfield, Illinois.

Date.	Hour of Observation.	Observed Temperature.	Mean Temperature for computing Reduction to Sea-level.
		°	°
1883, February 2	11 p.m.	32	—
„ „ 3	7 a.m.	33·5	—
„ „ 3	3 p.m.	26	30·5
„ „ 3	11 p.m.	15	25·
„ „ 4	7 a.m.	7	16·
„ „ 4	3 p.m.	8	10·
„ „ 4	11 p.m.	3	6·
„ „ 5	7 a.m.	−1	3·
„ „ 5	3 p.m.	11	4·
„ „ 5	11 p.m.	11	7·
„ „ 6	7 a.m.	16	13·
„ „ 6	3 p.m.	26	18·

For stations that telegraph but one observation daily, as in Europe, where the 7 or 8 a.m. (local time) observation is usually sent, it might be considered desirable to combine the morning temperature with that of the previous evening, usually 9 p.m., or to combine the morning minimum with the preceding maximum, or again to utilize to ordinary combination, $\frac{7 + 2 + 2 + 9}{4}$, or again simply correct the observed temperature for the average diurnal periodicity.

In all these methods such combinations are to be chosen that the monthly mean of the individual reduced barometers will sensibly coincide with the mean actual pressure reduced to sea-level by using the mean temperature of the month.

II.

In some such manner as above, the fictitious diurnal variation in the reduced barometer is approximately eliminated. We propose the above as the important point of the present communication; but in order to complete the reduction there remains still an important step, namely, to reduce the average temperature observed at the station to the mean of the air column.

The rate of diminution of temperature with altitude varies both with the season and the geographical location, and the method of determining it must be left to each country to settle for itself. In any case it is not desirable to introduce too great refinements into this computation.

Two methods of approximating to the mean temperature of the column of air which is assumed to replace the continents have been hitherto employed; one assumes that the vertical variation of temperature existing above the present continents can be carried down by extrapolation to the fictitious continent at sea-level; the other method assumes that the isotherms for those portions of the existing continents that are near sea-level can be prolonged by extrapolation underneath the highlands.

The defects of the first method increase with the height of the plateau, the defects of the second method increase with the geographical extent of the plateau.

For the United States, and, if we mistake not, for the whole world, the second method is to be preferred to the first.

Following this second method, we have projected low-level isotherms of the United States for each month, and have extended them across the interior, and underneath the elevated plateaus of the western portion of the continent. These represent the surface temperature at an average elevation of 500 feet. A sample copy of such isotherms for January 1883 is enclosed.

The difference between the mean temperature at a high station and the corresponding low-level isotherm, gives a monthly series of approximate allowances for altitude

We have thus completely provided for the temperature of the mass of air under consideration, and the completion of the reduction to sea-level becomes sufficiently simple.

The accompanying chart of isobars over the United States for 7 a.m., February 4, 1883, is prepared by means of Scott's tables and the hypsometric formula, and in accordance with the preceding considerations.

I am, &c.

(Signed) W. B. Hazen,
Brig. and Bvt.-Maj.-General,
Chief Signal Officer, U.S.A.

APPENDIX XI.

Remarks on the Reduction of the Barometer to Sea Level. (By E. Leyst. Presented by M. Wild.)

In dealing with the subject of the reduction to sea level of barometrical readings, we must first take into consideration the conditions to be fulfilled by a method of reduction. When these conditions have been laid down, we can discuss the question of the choice of the method of reduction to be employed in the construction of the International Meteorological Tables for the Reduction of Barometer Readings to Sea Level, proposed by the International Meteorological Committee.

These conditions may be classified under four heads, according to the limits of accuracy required. Other considerations, such as facility in using the tables, the dispensing with logarithms, &c., can only be regarded as of secondary importance. In the construction of the tables, the difficulty of their calculation, which is done once for all, can be of no great matter. Facility in using the tables is certainly very desirable, but this should not be secured at the expense of their accuracy.

The following are the four classes, according to the respective limits of accuracy :—

I. This class comprises the lowest standard of accuracy which is required, and this is admissible for synoptic charts, which aim only at representing

the general conditions of weather, in its main features, at a definite epoch of observation, and are intended for reproduction in weather charts, weather bulletins, and newspapers, for the use of seamen, fishermen, and the sea coast populations.

The value of such charts is only temporary. The limit of accuracy for such charts is 1 mm., and it is therefore of little importance what formula of reduction is used, provided this is not simplified too much.

II. This class embraces all cases which demand greater accuracy, but yet may be reduced by a simplified formula, if the differences of height can be diminished by a suitable choice of the level for reduction. The smaller continental countries come under this head, as they publish synoptic charts for small areas, and their own stations are far more numerous than their foreign ones.

Such charts are for the use of agriculturists, railway officials, and a limited number of readers.

Here the limit of accuracy laid down under I. will suffice for the foreign stations, while for the interior stations the reduction must attain the same degree of accuracy as is demanded of the observations themselves, namely, 0·1 mm.

III. This class includes all cases in which synoptic charts possessing permanent scientific value are constructed, in order to serve as a basis for scientific researches. Any one who is using such charts as those prepared at the Central Physical Observatory of St. Petersburg, at the Seewarte at Hamburg, or those of the late Captain Hoffmeyer, cannot possibly examine each individual observation in order to test the accuracy of its reduction. In such cases it is only reasonable to demand that the accuracy of the observations should not suffer owing to inaccuracy in the method of reduction. It therefore follows that for Class III. the limits of accuracy in sea-level reduction should be 0·1 mm.

For such charts the level of the sea is preferable to any other level chosen arbitrarily, owing to the great preponderance of observations from stations on the sea coast or on low-lying plains.

IV. This class embraces all cases of means of pressure laying claim to greater accuracy, such as the means of many years, for the construction of normal barometric charts, in which the accuracy is set at 0·01 mm.

For these the following conditions should be enforced:—

In the calculation of the tables for the reduction of the barometer to sea level intended for the International Meteorological Tables, such methods alone are admissible as will ensure an accuracy of—

0·1 *mm. for the individual observations.*
0·01 *mm. for the means of many years.*

The *method of reduction* comprises two parts, which are quite distinct from each other; the *formula of reduction*, and the *process of reduction*.

In the choice of the *formula* we have only to keep to the limit of 0·1 mm. or 0·01 mm., and reject all formulæ which do not satisfy these requirements. In the first place, it is obvious that an accurate formula intended to yield results useable under all circumstances, in all latitudes, at all heights above sea, at every reading of the barometer, at every temperature and every degree of humidity, must contain all those variables. It is moreover plain that empirical formulæ framed for certain conditions cannot be correct for all the conditions to be met with over the whole globe. Furthermore, not one of the empirical formulæ takes all the five variables into consideration, and if it can be proved that all of these variables have an influence on the result of the calculation, it follows that all the empirical formulæ must be rejected. The influence of altitude, of the barometer reading, and of temperature are undeniable, and we have therefore only to consider the two factors which have the least importance, the geographical latitude and the humidity.

At the height of 2,000 metres above the sea, and with a difference of 80° in latitude, the latitude gives rise to a difference in the reduction amounting to 0·88 mm.

The humidity at the same altitude, at a temperature of 20° C. and a relative humidity of 87 per cent., gives rise to a difference of 1·63 mm. We see, therefore, that neither element can be disregarded.

The only formula which meets all requirements is that of Laplace, as corrected by Bauernfeind and Rühlmann. What has still to be done is to calculate for this formula all the constants, according to the latest results of the science; and in addition to such a critical examination of the formula, this must be brought into such a form as will admit of the construction of non-logarithmic tables with double entry.

I myself have solved this problem, but have been prevented by other work from publishing my results.

When the formula is theoretically exact, we have to apply it correctly. This is termed the *process of reduction*, and it presents the greatest difficulties, as our knowledge of the natural laws involved in it is insufficient. The tables must be calculated by a correct formula of reduction, but the process of reduction, that is, the use of these correct tables, may be modified according to circumstances, without detracting from the value of the tables. The latter must, for instance, be calculated on the hypothesis that the methods of reduction yield mean temperatures of the assumed air column which are correct, and if subsequently other methods of calculating more correct mean temperature are discovered, the tables will not be affected thereby.

The most difficult part of the work of reduction is the determination of the temperature of the imaginary air columns, but this is not nearly so difficult as is generally supposed, for Bauernfeind, Rühlmann, and Belli have assumed that temperature is responsible for all defects in the formula and in the process of reduction, and even for all known omissions. Belli, Bauernfeind, and Rühlmann found the altitudes calculated from barometric readings did not agree with those determined by levelling, and they then inverted the formula, calculated a temperature which would give the correct altitude, and called this the "theoretical" temperature (Belli), or the "true" temperature (Rühlmann).

This theoretical or true air temperature did not agree with the observed temperature, and so Rühlmann concluded that the thermometers gave no information as to the real temperature of the air between the points.

It is therefore desirable to examine Rühlmann's investigation critically, for such an examination shows that it is not above suspicion.

The thermometer exposure during the Valtenberg observations appears to have been not quite perfect as against radiation. The reasoning is mainly based on the observations at Geneva and the Great St. Bernard; but these stations are so situated that no comparison of their results can be held to be quite satisfactory. The situation of the station at St. Bernard is so unsatisfactory that no wind observations can be published. The other station (Geneva) is situated on a large lake, and between the two stations there lie high mountains with glacial temperatures. For the night hours interpolations are made, and no hygrometrical observations at all are made at the St. Bernard.

Plantamour has supposed the existence of local depressions in the temperature observations, at one and even at both of these stations, and no one has considered that these stations are situated under different isobars and isotherms. Not only are the observations themselves unsuitable for such fundamental inquiries, but even the investigations themselves have not been carried out accurately, for Rühlmann has calculated not with his own accurate formula, but with Bauernfeind's; and finally in the calculation of the true temperature he has so greatly simplified the formula, that it cannot possibly yield correct results. In spite of all these omissions and defects of observations, the differences between the true and observed temperatures are smaller than those which may be introduced by errors in the barometrical observations.

Rühlmann's assertions are really based upon the slight amplitude of the "true" air-temperature,—which is frequently quoted as an incontestable truth,—compared with the large amplitude yielded by direct observations,

especially the comparison of the magnitude of the daily with the yearly amplitude. But this apparent decrease of the amplitude calculated in comparison with observation is only due to the formula used by Rühlmann. After he reduces it to

$$\text{I.}—h = \kappa\,(1 + \alpha\, t)\,\log\frac{B}{b},$$

and hence deduces the equation

$$\text{II.}—t = \frac{1}{\alpha}\left(\frac{h}{\kappa \log\frac{B}{b}} - 1\right)$$

where t is the temperature, h the height above sea, κ the barometer constant, α the coefficient of air, B and b the air-pressure of the lower and upper station respectively.

Before deducing from this incomplete equation daily and annual periods of temperature, Rühlmann should first have seen if the humidity had not a considerable influence, and he would have found that for July, the mean for 2 hrs., with the humidity of 100 per cent., gives a true temperature of 11°·4, and a humidity of 0 per cent., gives 13°·7.

The humidity therefore cannot be neglected.

When we consider these circumstances we cannot avoid greatly doubting Rühlmann's true temperature, and must seek other causes for the non-agreement between the barometric heights and those obtained by levelling, or what is the same thing, for the exactitude of the reduction to sea level.

What makes the reduction unreliable is that the decrease of temperature with height has not yet been sufficiently investigated. The calculations hitherto carried out give different values for each mountain, for each side of a mountain, for each position, for each month, for each hour of the day, and even for each condition of weather.

What we have just said about temperature holds good for humidity also, the vertical decrease of which is just as little known, and therefore this as well as the decrease of temperature must be thoroughly investigated.

The *deviations due to local attraction* are also in most cases unknown, but its influence on the reduction is so small, that it vanishes by the side of the errors caused by temperature and humidity. The *height above sea* is often very doubiful, although it may have been determined by levelling. The levelling has been carried out with observations instituted for other objects, as *e.g.*, for railroads, and these are not above all objection.

Lastly, we have to consider the *air-pressure*. Groundless objection has often been raised against Laplace's formula for heights, that it presupposes a statical condition of the atmosphere, while in reality the condition is dynamical. It may be stated against this objection that Laplace by no means presupposes a state of equilibrium of the atmosphere, but he has only put the vertical component of the movement of a particle of air equal to zero, while as regards the horizontal component he has neither made any assumption nor had any necessity to do so. Rühlmann has not used the horizontal component at all in his work, but has made the remark, wrongly as it appears to us, that "the state of atmospheric equilibrium" is presupposed in the deduction of the formula.

The supposition only refers to the vertical components, and is justified by the fact that the atmosphere really has a tendency to restore its equilibrium when disturbed.

As perfect equilibrium cannot exist in the vertical direction, we have to show how great is the influence of this disturbance, in which way it exerts itself, and how far it depends upon daily and yearly periods. Isolated elevated stations are most suitable for this purpose, if they lie in the region of cyclone paths or of anticyclones. We should have to expect large amounts, if a cyclone is forced to traverse a mountain chain, say 5,000 metres high, and great disturbances of the surfaces of level must occur.

On the basis of the above remarks, which will be eventually published separately in a more detailed form, we beg to make the following pro-

posals to the International Meteorological Committee as a preparation for a future Meteorological Congress:—

(1.) The subject of the reduction to sea level should be declared not yet ready for decision, as at present neither the formula for the calculation of international tables for the reduction of air-pressure to sea level can be accepted, nor can a process of reduction be settled.

(2.) It would be consequently necessary to invite meteorologists to submit to a critical examination the deduction of Laplace's formula for heights, or the formulæ of Bauernfeind and Rühlmann to alter the constants according to the most recent determinations, and to modify the formula for the reduction to sea level in such a way that an accurate calculation without the use of logarithms may, with the use of tables, be effected, and in which all variables, such as height above sea, air-pressure, temperature, humidity, and geographical latitude are duly taken into account.

(3.) To request meteorologists to make the vertical distribution of humidity and temperature the subject of thorough and comprehensive investigations; to study these elements, especially in different conditions of weather, and in different parts of cyclones and anti-cyclones.

(4.) To invite those meteorologists who have the opportunity, to deal with synoptic meteorology, to investigate pressure observations of very elevated stations, that have been reduced to sea level at times of great atmospheric disturbances, with a view of indicating possible influences of vertical movements of the atmosphere upon the reduction of pressure to sea level.

(5.) To request editors of meteorological journals to turn their attention to the questions referred to in these proposals, until the meeting of the next Meteorological Congress, by furnishing their readers with detailed reports and reviews of contributions bearing upon the subject.

E. Leyst.

Pawlowsk Observatory,
July 1885.

APPENDIX XII.

Report on the Reduction of Barometer Observations to Sea-Level. By The Deutsche Seewarte.

It may be first stated that the historical introduction of the letter of the Chief Signal Officer contains some mis-statements, as the "isobarometric lines" of Kämtz have no connexion with the "isabnormal lines" of the Americans. The former are lines of equal mean monthly variations of the barometer, and the latter are lines of equal deviation (from the normal), of the reading of the barometer for a given moment of time, or for a given month (Dove's "isametral" lines). And the latter method was not generally abandoned in 1857, but, in Russia and Austria, was only given up subsequently to the Vienna Congress of 1873.

The proposal to take as a basis for the calculation of the air-temperature to be used in the reduction the mean of the last three observations, appears to have no prospect of being generally accepted, for the following reasons:—

(1.) The investigations of Rühlmann and others show that the daily oscillation of the temperature of the free air is only less than that at the earth's surface, but that it is not to be neglected, for the variation of the daily period of air pressure with height, on isolated mountains, is pretty accurately explained by the daily variations of temperature in the free atmosphere. The difference between the mean values at a station and in the free atmosphere is, according to Rühlmann, nearly the same as that of the extreme hours and extreme months, so that the daily means do

not generally give the most accurate reduction, but in the coldest month the warmest hour, and in the warmest month the coldest hour (or the nearest to it).

(2.) The anomalies and incongruities between neighbouring stations of different heights, which occur in the reduction to sea-level, are by no means restricted to the daily period, but depend on other causes as might be seen in Europe where, until recently, the morning observations only could be compared with each other. The first difficulty occurred at the time of the adoption of the method in Austria in 1874, during the winter at Hermannstadt, which being situated in an elevated valley, showed abnormally low temperatures on 1st—9th January; these, when used in the reduction, plainly gave too high a value for the pressure at the sea-level, so that Hann proposed (Zeitschrift der Oesterr. Gesellschaft, 1874, p. 1 *et seq.*) to carry out, at all stations above 100 metres, the reduction by means of the normal monthly mean temperature.

Hann's proposal goes still somewhat farther, as he would also disregard the influence of the variation of pressure on the reduction, and proposes a constant reduction for each month, only clothed in another form. (He would apply, for instance, at such stations the existing deviation from the normal, without a proportional increase in the normal readings reduced to sea-level.)

(3.) The supposed introduced retardation of the non-periodical variation of temperature by the proposed method causes the results to be affected with a systematical error, which is the greater since in fact variations of temperature of this kind occur more rapidly in the free atmosphere, or in the higher strata than at the surface of the earth, as the irregularities of the latter prevent the rapid renovation of the masses of air, and the proximity of land or water changes the temperature of the fresh masses of air which are approaching and assimilates them to that of the air which has preceded them. We must make a careful distinction in this respect between the changes of temperature caused by radiation and by transport of air. In the former case, which especially influences the daily period, the nature of the fixed base is the most active element; in the latter case every body which does not change its place with the air operates in an obstructive manner.

(4.) Finally, we must take into consideration against the proposal the serious fact that the values so reduced are not, as is the case with the method employed at the Seewarte, available for more accurate discussion by the application of further corrections, but that such a conversion would be so troublesome and uncertain that a complete recalculation of the original values would be preferable.

General considerations.—Every person reducing meteorological observations taken at the surface of the earth to an ideal lower level finds himself in this difficulty; it is impossible to put the problem simply. For at the place, to which we wish to transpose the barometer reading or air-temperature by reduction, no air exists, but if we sink a shaft to the required depth, the temperature of the air in the shaft, and therefore also its pressure, are altogether different owing to the influence of the solid surrounding from that which we wish to assume as a basis for the reduction. But in the case of the reduction to a higher level, circumstances are more favourable, for here we take into the calculation the air-pressure or temperature which probably actually prevails there.

If, for various reasons, we cannot adopt the introduction of a reduction to a higher instead of a lower level, then, as here what we aim at is not real, the object must be decisive in the choice of the method.

The principal object of the reduction to sea level is to obtain for the air currents at the surface of the earth a picture representing the distribution of air-pressure, such as especially an isobaric chart. We require, therefore, for an uneven country, something strictly speaking, impossible, as the horizontal distribution of air-pressure, when horizontal differences of temperature exist, differs with each level. We must here consider different cases of as simple a character as possible.

1. *Plateaus.*—Given a tableland with a number of stations at the same level with different air temperatures. Here the reduction with regard to the

existing temperature will give a distribution of pressure for the ideal sea-level, which differs from that of the tableland itself, and a fictitious difference of pressure results from the reduction between two stations of the same height, and in reality having the same pressure, as colder stations always get a higher pressure than the warmer station. The amount of this fictitious difference of pressure, when the lower pressure is not far from 750 mm., is given by the equation—

$$B - B^1 = 24h\frac{T^1 - T}{T\,T^1}$$

where T is the temperature measured from $-256°$. If, *e.g.*, $T = 270$, and $T^1 = 280$, then between the two stations, Bayreuth and Ratisbon, which are equally high, viz., 359 metres above sea-level, we get a fictitious difference of pressure of 1·1 mm. by the reduction, if the pressures are the same at both stations. In reality there was not only no such gradient in the atmosphere at the surface of the earth between Bayreuth and Ratisbon, but even, as the country between both places is somewhat higher, there would be a small gradient in the opposite way, from the warmer to the colder place. For the determination of the distribution of pressure and of the air-currents on an horizontal plateau, if (for casual comparison with low lands) a reduction to sea-level is to be effected at all, an identical correction for the whole area would be preferable.

2. *Declivities.*—In the case of an inclined plane between two stations, a consideration of the question shows that an approximate knowledge of the distribution of pressure at one point of the line of junction (with reference to this line) would be best gained by reducing the upper station downwards, and the lower station upwards, to the level of this point, taking the observed temperature of both stations and the probable vertical decrease of temperature in this district, or over the lower station, as a basis for the reduction.*

3. *Stations in Valleys.*—If the district between the stations is higher than the stations themselves, then, as before stated, in deducing the distribution of air-pressure and the conditions of the wind, the reduction should be made upwards on both sides, by which means the differences of temperature have an opposite influence to that which they have in the reduction downwards.

From these considerations it follows—

(*a.*) The consideration of the horizontal differences of temperature in the reduction to a uniform level is only of advantage so far as the distribution of pressure in this selected level is of actual interest; the latter is not the case for the fictitious distribution of air-pressure at the sea-level under table lands, but it is so in all reductions to a mean or higher level. The consideration of the horizontal differences of temperature, therefore, recommends itself for the portion of the height which lies between the stations, but not for that which is common to all or most of the stations of the area in question, or which lies below the selected mean level of the latter.

(*b.*) In order to gain an insight into the main features of the atmospheric pressure over the globe, we can make the air-pressure of mountainous countries and table lands, reduced to a selected mean level, comparable to that at the sea-level, by the addition of a proper number of millimetres, which is uniform for the former level, so far as the nature of the case will allow this to be done. Hann very properly proposes to use the normal monthly means of temperature as a basis for the reduction to this temperature.

For this an average value is to be chosen according to the conditions of that table land, for the reduction of the level in question to that of the sea-level, with which value the comparison should be made by preference, with the addition of the mean decrease of temperature as far as half the height of the level. For a useful application of this reduction it is presupposed that the height above the sea of that mean level is not so

* M. Léon Teisserenc de Bort first proposed to the International Committee at Copenhagen in 1882 to calculate the gradients on declivities by a very similar method. (See App. VII. of that Report.)

great as to cause the horizontal distribution of pressure at the corresponding level above the adjacent lowlands, or the sea, to be essentially different from that which is represented on the synoptic charts for the level of the sea. As the non-periodic variations and the differences dependent upon locality amount in all zones to about as many millimetres in air-pressure as centigrade degrees in temperature, the upper limit should be taken at a height in which a lower difference of air-pressure of 1 mm. is equalised by a mean difference of temperature of 1° C. in the column of air, and this is the case at 2,500—3,000 metres, a level below which more than one quarter of the atmosphere lies.

(c.) In the weather reports of the Seewarte the foregoing views are applicable in the following manner:—

If we adopt 300 metres above the sea as the mean level for south and central Germany, the mean temperature in this stratum, or the temperature at a height of 150 metres is as follows:—

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Assuming a decrease of temperature per 100 metres = - - - -	0·3	0·5	0·66	0·66	0·7	0·8	0·7	0·7	0·6	0·5	0 5	0·3
According to Leipzig (119 metres) -	−1·3	0·7	3·0	8·1	12·8	16·0	17·8	17·3	13·7	8·8	2·9	−0·1
„ to Münster (63 metres) -	0·9	2·4	3·7	8·1	11·9	15·4	16·9	16·4	13·9	9·8	4·2	2·1
„ to Wiesbaden (111 metres)	−0·5	2·2	3·9	9·2	13·4	16·6	18·4	17·5	14·0	9·2	3·9	0·6
„ to Carlsruhe (123 metres)	0·7	2·6	5·4	10·6	14·7	18·0	19·7	19·0	15·6	10·4	5·0	1·6
„ to Bamberg (233 metres)	1·0	1·3	4·7	9·4	14·6	17·6	18·8	18·6	15·0	9·4	4·5	0·1
Mean - - - - -	0·4	1·8	4·1	9·1	13·5	16·7	18·3	17·8	14·4	9·5	4·1	0 9
Corresponding to a reduction to sea-level* - - - - -	27·9	27·7	27·5	27·0	26·6	26·2	26·1	26·1	26 3	26·9	27·5	27·8

Assuming a lower barometer reading = 760 mm., according to the formula:—

$$2{\cdot}8808 - \log b = \frac{300}{18460 + 72t}.$$

The advantage of using the normal temperature for the different months is, however, not very great; for, as in Germany, the extremes of temperature in each month differ as much from each other, at least on an average, as the mean temperatures of the warmest and coldest months, so that the maximum temperature in January and the minimum temperature in July are pretty near the yearly mean. As these two extremes generally occur in cloudy weather, the daily period has no great influence upon them. We can estimate that in the extreme months the actual temperature lies nearer to the yearly mean in about one-sixth of the cases than to the normal monthly mean. For the weather reports of the Seewarte, in which the coast stations play a principal part, the conditions below 150 metres above the sea have such a paramount importance, that it is desirable to retain the direct reduction to the sea-level which is now employed, with the yearly mean temperature, for all stations below the specified mean level of 300 metres, in order in this lower level to avail oneself of the practical advantages of this method as given some time since by the Seewarte, and especially to prevent a complete break in the transition from one level to another, which would not be possible in the proposed partial reduction upwards.

Up to this height the differences occurring in the reduced values, by taking into consideration the temperature with the monthly mean, do not in fact amount to 1 mm., while with the extreme individual temperatures they certainly amount to 2 mm. For the two German stations in the weather reports, which are situated above this level, Munich and Friedrichshafen, these deviations, on the contrary, reach 4–5 mm., and even more, so that they may cause an essential distortion of the isobars, and even an inversion of the gradients. It is to be recommended in reducing the barometer readings of these stations in the Weather Reports for the stratum above the adopted limit of 300 metres, to take the

existing temperature into consideration, by applying the corrections (which have only been calculated provisionally):—

t =	−20°	−15°	−10°	−5°	0°	+5°	+10°	+15°	+20°	+25°	+30°
Munich	+2·2	+1·8	+1·5	+1·1	+0·7	+0·3	−0·1	−0·5	−0·9	−1·2	−1·6
Friedrichshafen	+1·0	+0·8	+0·6	+0·5	+0·3	+0·1	0	−0·2	−0·4	−0·6	−0·7

As for t is to be taken the probable temperature halfway between the stations and 300 metres, we have, generally, to add to the station-temperature for Munich $0°{\cdot}58 \times 1{\cdot}25 = 0{\cdot}7$ and for Friedrichshafen $0{\cdot}58 \times 0{\cdot}53 = 0{\cdot}3$. This correction may be neglected, and the temperature at the station be simply taken.

(*d.*) Although the mean altitude of the large tablelands in the west of the United States is only about half the above-named height of 2,500—3,000 metres, it is still doubtful whether for these plateaus, especially so far as they are separated from the lower countries by high mountains, the approximate reduction to sea-level is suitable, and whether it would not be better to draw double isobars; for the sea-level, and for an upper level, *e.g.*, 1,500 metres=5,000 feet respectively, over the lowlands both, and for the upper level solely over the highlands? Such a system would undoubtedly prove very useful for study and for the purpose of forecasting.

(*e.*) The daily period of temperature should properly speaking not be excluded, but, like all other (periodical and non-periodical) effects of radiation, should be lessened. But as the measure of this diminution must in most cases be arbitrary, its exclusion may be of advantage. If this is the case, it should certainly not be done by the one-sided compensation of the variations of temperature as has been proposed; but by applying its normal amount to the reading, that is, by the reduction of the latter to the daily mean.

Hamburg, 15th June 1885.

APPENDIX XIII.

Report of the Sub-Committee on the Subject of Telegraphy with America.

The Sub-Committee desires to report that it has had the honour of a conference with General Hazen, and has found that officer most ready to impart information, and to conform himself as far as possible to the views and wishes of European meteorologists.

The Sub-Committee feels that it should express its conviction that, had it not been for the initiative taken in 1884 by the Meteorological services of France and the United Kingdom in organising a system of reports of bad weather experienced by ships arriving in America, the subject of Atlantic telegraphy would hardly have been considered ripe enough for discussion at the present meeting.

It would further acknowledge the promptitude with which General Hazen and the staff of his office have complied with the requests made to them from this side of the Atlantic, and the zeal with which the representatives of the Chief Signal Office in New York and Boston have carried out the details of the system as it exists.

The Sub-Committee has considered the subject of Atlantic telegraphy from two points of view:—

A. The despatches obtained from ship's logs.

B. The despatches relating to phenomena existing on the American continent.

A. The Sub-Committee considers that the advantages which navigation derives from such a system of telegraphy of facts, relating to storms, icebergs, and derelict ships, as has been hitherto in operation, are indisputable. It therefore recommends that the service should be maintained in activity, and that the distribution of the reports should be extended to all nations in Europe that may wish to participate in their reception, and

will bear a share of the expense. It appears from information supplied by the Meteorological Office that the cost hitherto incurred for these telegrams has been:—

American Telegrams.

Month.	No.	U. S. to M. O.			M. O. to Paris and Utrecht.		
		£	s.	d.	£	s.	d.
December - -	10	6	17	8	—	—	—
January - -	14	7	14	—	—	—	—
February - -	12	5	13	6	—	—	—
March - - -	17	5	4	—	*1	1	9
April - - -	12	3	7	6	*—	15	8
May - - -	19	6	2	9	3	11	3
June - - -	28	8	1	6	4	18	—
July - - -	20	5	—	—	2	1	5
	132	£48	0	11	£12	8	1

* Paris only. Repayment 24*l.* 11*s.*

As regards the form of the telegrams, the Sub-committee recommends the insertion of the degree of latitude in which each phenomenon has been observed, as the statement of the longitude alone has been found insufficient to fix the positions, inasmuch as steamers are found not to confine themselves to the limits of "steamer lanes."

It further recommends the extension of the limiting meridian for the commencement of the storm reports to 40° W. from 45° W.

The Sub-Committee further considers that the return of the filled up forms to the Office in Europe which issues them to ships is of very great importance.

B. With reference to the proposal for daily reports of American weather, General Hazen stated that, if application were made, his office would be ready to prepare and transmit a brief digest of his 10h. p.m. (Washington) observations, which might thus be forwarded at "press rates," and arrive in Europe in time for publication in the several European bulletins of the succeeding day.

The Sub-Committee considers that no advances should be made in this direction until the financial part of the question has been satisfactorily settled, and that under any circumstances our knowledge at present is not sufficient to justify the adoption of a system of types such as M. Léon Teisserenc de Bort has proposed.

It would therefore recommend that the entire subject of the amount and character of the information to be transmitted should be left to the discretion of the Chief Signal Office.

(Signed) Dr. Neumayer.
Robert H. Scott.

Paris, September 4, 1885.

APPENDIX XIV.

Remarks by Capt. J. C. de Brito-Capello, Padre Denza, and Mr. Symons, on the Classification of Days of Snow, and on the Height of Rain-Gauges.

(1.) Snow.

I think we should define a day of snow to be one on which snow has fallen either in a small or large quantity. If rain has fallen at the same time, or during the interval, the same day should be classified as a day of rain and a day of snow.

(2.) Rain-Gauges.

It is very desirable that we should adopt one uniform height above the ground for rain-gauges at all meteorological observatories and stations.

If this measure should be adopted, observations should be made with the old rain-gauges for two or three years by the side of the second, at the height adopted, and at a distance of 2–3 metres apart, in order to obtain the corrections to be applied to the old observations.

(Signed) J. C. de Brito Capello.

Observatory, Lisbon,
July 1, 1885.

Italian Meteorological Society, Moncalieri,
14th August 1885.

Sir,

Some extraordinary falls of snow encumbered the valleys and mountains of our alpine countries during the last winter.

Under these circumstances we endeavoured to determine as carefully as possible the depth of the snow-fall, for this determination was of great interest for our researches. But we met the greatest difficulties in obtaining measurements at all comparable with each other.

With this object, the Italian Meteorological Society, which possesses several mountain stations, requests the members of the International Meteorological Committee to take *the more exact measurement of snow* (No. 13 of the Programme) into serious consideration. This is always very uncertain and very variable, according to the observers, and yet it is one of the most important climatological factors, especially in mountainous regions.

It will always be difficult to obtain an exact measurement of snow, especially on mountains, owing to many circumstances, but chiefly to the violent winds which very often accompany the fall. It would be very interesting, however, to have rules which are as uniform as practicable to which we might conform.

The society also recommends to the International Committee, No. 11 of the Programme, viz., the precise definition of days of rain and of snow, which often give rise to confusion.

(Signed) Father F. Denza,
Director General.

62, Camden Square,
London, N.W.,
August 29, 1885.

Dear Mr. Scott,

I am sorry to be so late in thanking you for the honour you have done me in forwarding a copy of your circular of May 1st.

I append a few remarks on questions 13, 14, and 15.

Yours very truly,
(Signed) G. J. Symons.

R. H. Scott, Esq., M.A., F.R.S.

Question 13.—I should define as a day with rain or snow every one in which 0·006 inch (0·15 mm.) of water is indicated by the gauge. I am aware that by this rule there will be a few days in the year when dew will be entered as rain, but no rule is perfect, and as dew cannot be kept out of gauges visited only monthly or weekly, I think that it would lead to error to omit its entry from records taken daily.

Question 14.—A rain-gauge should never be fixed where snow drifts of excessive depth are frequent, but on the contrary, where the depth of snow is usually about the same as over the surrounding country. The depth of snow likely to fall in one day seems to me the test of the lowest height at which the funnel should be placed. I am not aware of any locality where a metre of snow falls usually in one day, without drift. I should therefore regard that as the extreme height.

I have carefully watched the rebounding of rain and hail in heavy showers, and have also noticed the height to which garden mould and fine gravel are splashed and have never been able to trace it beyond one third of a metre (12 inches). Thus far the limits therefore appear to be between 0·3 inch and 1·0 m., but there are other points to be considered. It is often necessary to place guages on mountains and in exposed positions, and there is great risk of their being maliciously interfered with if they are found by tourists, and the only mode of lessening this evil is by keeping them low and inconspicuous.

Lastly, that which we require to know (especially for hydraulic engineering) is how much rain reaches the soil. Careful experiment has shown that the fall at 1 metre, accurately at 3 feet, is three per cent. less than the fall at 0·3 metre (1 foot).

If, therefore, a uniform height can be adopted, it should, I think, be very little more than 0·3 metre.

Question 15.—This is very difficult, especially in this country where the fall frequently is a mixture of snow and of rain, or where the one changes to the other. I annex the rules issued to British observers, but I shall be glad to consider any suggested improvements.

15.—Snow.—In snow three methods may be adopted; it is well to try them all.

(1.) Melt what is caught in the funnel by adding to the snow a previously ascertained quantity of warm water, and then, deducting this quantity from the total measurement, enter the residue as rain. (2.) Select a place where the snow has not drifted, invert the funnel, and turning it round, lift and melt what is enclosed. (3.) Measure with a rule the average depth of snow, and take one twelfth as the equivalent of water. This being a very rough method, is not to be adopted if it can be avoided. Some observers use in snowy weather a cylinder of the same diameter as the rain-gauge, and of considerable depth. If the wind is rough, all the snow is blown out of a flat funnelled rain-gauge. Snowdon pattern gauges are much the best.

APPENDIX XV.

(M.O. 1482.)

Royal Meteorological Society,
30, Great George Street, S.W.,
July 7th, 1885.

Dear Sir,

The Council of this Society have considered the circular letter of the International Committee of Meteorology dated May 1st, and beg to submit for the consideration and decision of the International Committee the following questions, viz.:—

1. A standard velocity anemometer.
2. The general adoption of an uniform height of anemometer above the ground.

Yours, &c.
(Signed) William Marriott,
Assistant Secretary.

R. H. Scott, Esq., F.R.S.,
Secretary,
International Committee of Meteorology.

APPENDIX XVI.

Report by Dr. G. Hellmann respecting International Meteorological Tables.

In the March number of the *Zeitschrift der oesterreichischen Gesellschaft für Meteorologie* 1879, I published a proposal dated 21st January of that year, for the publication of a collection of Meteorological Tables for international use, which I repeated orally at the subsequent Congress at Rome. The proposal met with general approval, and was referred to the International Meteorological Committee for execution, or for taking the necessary steps for that purpose.

The Committee has in fact considered the scheme at each of its subsequent meetings, and a special sub-committee has prepared a plan for these International Tables (*see* Copenhagen Report, 1882). It appears, however, that this very useful undertaking has not advanced beyond that stage, and that any further steps in the matter have been postponed, owing to the proposed new edition of Guyot's *Smithsonian Meteorological and Physical Tables* (*see* Berne Report, 1880). This postponement was so far justifiable, as up to the present time Guyot's collection was the largest, and, thanks to the liberality of the Smithsonian Institution, had been the most widely distributed. We might have expected that in a new edition the wishes expressed at the Meteorological Congresses, and the present requirements of meteorology, would have been duly taken into consideration. The new fourth edition is now published "*revised and enlarged*" it is true, but judged from a meteorological point of view, it must be said to be incomplete, and absolutely insufficient for the modern requirements of meteorology. Many useful geographical tables have been added, but the meteorological tables are scarcely changed. The tables referring to the daily periodical and the monthly non-periodical variations of temperature, which embrace over 100 pages, have simply been reprinted. Fifty years ago these tables were certainly the best extant, but they have long ago become obsolete. I therefore beg to recommend my proposal of the year 1879 again to the International Meteorological Committee for their consideration.

Berlin, 26th July 1885.

Report by Dr. Hellmann on the Reckoning of Rainy Days.

I beg respectfully to point out to the International Meteorological Committee that the existing very different ways of reckoning rainy days (≋ ⁂ ▲ △) will cause serious defects in comparative climatological investigations. It is very desirable that this should be removed by international agreement. This difference could certainly be avoided by the use of M. Köppen's proposed method for the calculation of the probability of rain from the observations at regular hours, but then the previous long series of observations, where the rainfall at the moment of observation is not noted, could not be used at all, and the term "rainy day," which is easy to be understood, must be entirely abandoned. This seems to me to be very unadvisable in the interest of the practical use of meteorology. The method of counting which seems to be the most natural is to reckon as "rainy days" all days on which rain has fallen, whether it be a large quantity, or only drops which cannot be measured. But this method would only give really comparable results if the observations could everywhere be made with the same care. This is, however, naturally not the case, for at an observatory, with several observers whose special duty it is to watch the changes of weather, many more days with rain of the smallest, or unmeasureable, quantity will be noted, than at a neighbouring station of the second or a lower order, where the observers treat meteoro-

logical observations as a secondary occupation, and however conscientious they may be, can only devote their occasional attention to the weather between the regular hours of observation.

In order to obtain comparable numbers, it has therefore been determined in some systems of observations to fix a minimum limit of rainfall for days with rain. In England the praiseworthy practice of adopting 0·01 inch* as such, has been followed for many years, and, adhering to this practice, I have selected 0·2 mm. in Prussia for this purpose since 1st January 1883; but in other European systems of observations, if any limit at all has been introduced, 0·1, 0·3, and sometimes even 0·5 mm., have been adopted as the minimum limit. It is evident that methods of counting, which are so essentially different, must give results that bear no comparison to each other.

Without wishing to anticipate the decisions of the Committee upon this question, it appears to me most advisable to keep to the method followed in England. It remains a matter for simple agreement whether the minimum quantity shall be 0·1 inch, or 0·2 or 0·3 mm., but for the reasons stated above I would give the preference to the first figure.

Berlin, 24th July 1885.

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* 0·01 inch = 0·254 mm., but as in the metric system the rainfall is generally only accurately measured to tenths of millimetres, and on the dry continent the losses by the moisture [clinging to the gauge], evaporation, &c., cause greater sources of error in the case of small amounts than in England, where the air is damper. It appeared to me that rounding off the quantity to 0·2 mm. would be the best.

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REPORT

OF

THE FOURTH MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

ZÜRICH, SEPTEMBER, 1888.

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REPORT

OF

THE FOURTH MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

ZÜRICH, SEPTEMBER 1888.

Protocol of the First Meeting, 3rd September 1888.

THE MEETING was opened at the Polytechnic Institute, at 10h. 15m. a.m.

Present: MM. Wild (President), Buys Ballot, de Brito-Capello, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

The PRESIDENT, in opening the meeting, welcomed the members, and said that he noted with pleasure that all the members of the Committee were present on this important occasion. In compliance with the unanimous desire of the members, he invited M. Billwiller, Director of the Central Meteorological Office of Switzerland, at Zürich, and Mr. B. A. Gould, at present residing there, to take part in the proceedings of the Committee.

The PRESIDENT went on to say that the Executive Officers, having only had in the interval between the last Meeting at Paris and that of to-day, to settle some unimportant matters, had not thought it necessary to draw up a special report, and he would therefore restrict himself to a brief reference to these matters.

The report of the Meeting at Paris, in 1885, has been published in three languages, and distributed as usual among meteorologists.

Thanks to the care and perseverance of M. Mascart, the calculation and publication of the International Meteorological Tables is now quite assured, and in course of execution, so that meteorologists will shortly have in their hands these tables, which are so much desired.

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The proposal made at the Meeting at Paris in 1885 to convene a third International Congress at Paris in the year 1889 has been discussed by correspondence among the members of the Committee, and the great majority of the members considered that there was no prospect at present of carrying out this proposal, inasmuch as many of the Governments still declined to look favourably on the convening of such a Congress, and as, moreover, no important questions had as yet been proposed to be submitted to it.

In the opinion of the majority of the members this impossibility of convening again an International Congress placed the Committee in the unfortunate position of inability to complete its mission, and of continuing its functions much beyond the period contemplated by the Congress of Rome. And as, according to the resolutions of that Congress, the Committee could neither augment the number of its members by the co-option of the chiefs of several important services into its body, nor could it decide any fresh questions which might present themselves, several members considered its future utility placed in doubt. The question was accordingly raised whether the time had not come for replacing both official meteorological Congresses and their International Committees by another kind of assemblage, as, for instance, by a conference of the chiefs of the different meteorological systems. These considerations seemed to the majority of the members sufficiently important to be discussed this year, and consequently it was decided to hold a fourth meeting of the Committee at Zürich on the 3rd September.

The PRESIDENT also announced that the Executive Officers had not proposed any programme. There were some questions the decision of which had been postponed for a future Congress by the last Meeting at Paris, and the Committee had to decide whether these questions could now be settled. There were, besides, some new questions proposed by various members for submission to the Committee, and these had been embodied in a provisional programme.

The Committee decided to accept the provisional Programme; but, for the present, to discuss only the new questions, and this Programme was adopted, together with certain supplementary proposals made by MM. Buys Ballot and Wild (Appendix I.).

On the invitation of the President, M. Mascart gave some particulars as to the present state of the publication of the International Meteorological Tables, and he presented to the Committee the proofs of the first 16 sheets. He stated that all the calculations were finished, and that the manuscript was ready for printing. Various difficulties, and the experiments necessary in order to arrive at a definite form for the tables, had taken much time, but he now hoped that the work would be distributed next year. He stated that 240 copies had been subscribed for by different countries and institutions, and that the subscriptions towards the expense of calculation now amounted to 77*l*.

He further stated that the French Academy of Sciences had voted 40*l.* for the same purpose.

The contributions of some important countries, such as France, Germany, Russia, &c., were not included in this amount; it would be seen therefore that success of this important undertaking of the Committee was assured.

The PRESIDENT expressed to M. Mascart the sincere acknowledgments of the Committee of the zeal he had shown in the preparation of these tables.

The discussion was opened on Question 14 of the Programme :— "The classification of clouds."

M. HANN stated that he had received from the Meteorological Office a copy of a proposal made by MM. Hildebrandsson and Abercromby, and that up to the present he had not expressed any opinion upon this subject.

MR. SCOTT stated that the proposal had been communicated to the Royal Meteorological Society in February 1887, and that the Meteorological Office had assisted in the reproduction of the photographs, by the purchase of certain number of copies, which had been distributed to correspondents of the Office. The opinions which had hitherto been received had not been very favourable to the adoption of the system proposed.

M. NEUMAYER remarked that there would be a serious confusion if the Committee were to recommend the system of cloud classification proposed by MM. Hildebrandsson and Abercromby, because opinions on the character of the clouds had, up to the present time, been very divided. There were some hundreds of observers who made use of the existing system, and at the present time the observations in ships' logs might very well be compared with each other. He was of opinion that it was very desirable to continue the study of the forms of clouds in order to arrive definitely at a system which might be proposed for general adoption.

M. WILD remarked that from an inquiry carried on at the Central Physical Observatory at St. Petersburg, it had been found that the photographic reproductions of clouds, issued with the pamphlet of MM. Hildebrandsson and Abercromby, were not clear enough to enable ordinary observers to distinguish between the different forms. For this object larger pictures, and especially in colours, were necessary, in order to show the appearance of the sky behind the clouds.

M. MASCART thought that a special recommendation should be made to the different institutions to obtain a collection of photographs of clouds, and to endeavour to get satisfactory reproductions in colours.

The Committee adopted the following resolution :—

"*The Committee considers that it cannot at present recommend the general adoption of the proposal of MM. Hildebrandsson and*

Abercromby, but it recommends meteorologists to continue their study of this question in order to obtain representations, both photographically and also in colours, such as might be introduced generally in Meteorological Instructions."

The discussion was opened on Question 15 of the Programme :— "The conditions to be recommended for the publication of observations from distant stations."

M. HANN was of opinion that, as a considerable number of reports relating both to meteorology and climatology, were published by travellers and geographers, it would be well lay down rules for publishing the results, especially if they were to be utilised for scientific researches.

1. It should be stated what kind of instruments had been used for the observations, their corrections should be given, if known, as well as details as to the method of exposure. The height of the barometer above sea-level should be given as accurately as possible.

2. Precise information as to the methods employed in the calcution of the means (the hours of observation, and the formulæ used for reductions) should always be given.

It is further desirable to give the means for the separate hours of observation (for temperature, humidity, and atmospheric pressure), to facilitate the reduction to true means, which might be undertaken subsequently.

3. In publishing means for several years, it is very desirable to give the separate means for periods of five years each (lustra) (commencing with the first year of each pentade:—1881–5, 1886–90, &c.), in accordance with the resolution of the Congress of Vienna. In this way it would be possible to obtain with the greatest facility simultaneous and corresponding mean values such as are indispensable for any serious investigations on the distribution of meteorological elements, especially temperature, atmospheric pressure, and rainfall.

The Executive Officers were earnestly requested to publish these rules in Meteorological Journals, in various languages, as soon as possible.

The Committee agreed with M. Hann's opinion upon this subject, and accepted his proposals.

The discussion was opened on Question 16 of the Programme:— "The improvement of telegraphic reports" (M. Capello). Appendix II.

The Committee recognized the importance of M. Capello's proposals, and recommended the Directors to study the means of suitably introducing this addition in their telegraphic reports.

The discussion was opened on Question 17 of the Programme :— "Warnings to ships at sea." Appendix III.

The Committee recognized the importance of the steps taken by M. Capello.

The meeting was adjourned at noon, and the sitting recommenced at 2 p.m.

On the resumption of proceedings the discussion was opened on Question 18 of the Programme:—"The time of observing rainfall."

M. WILD remarked that he had found serious inconvenience in having to enter the rainfall and snow at 7h. a.m. in the registers of the previous day, while in the telegrams they were given for the day on which they are measured. This inconvenience would not occur if the fall were measured at the last hour of observation, for instance, at 9h. p.m.

M. BUYS BALLOT agreed with M. Wild as to the advantage that would be found in the measurement of rainfall, &c. at the time of the last observation in the evening.

MM. MOHN, MASCART, and SCOTT called the attention of the Committee to the very considerable number of observers who measured rainfall in the morning, and urged the difficulty of introducing a general change.

The Committee decided not to propose any alteration at present.

The discussion was opened on Question 19 of the Programme:—"The publication of hourly observations."

M. HANN desired that all the materials should be published *in extenso* for at least five years.

M. TACCHINI asked whether it was considered necessary to publish *in extenso* the results from all stations provided with self-registering instruments. He thought it would be well to limit such a publication to a small number of stations, while for the other stations the publication should be limited solely to summaries for months and decades. He requested the Committee to come to a decision upon this question, as the number of stations was continually increasing.

M. MASCART shared the opinion of M. Tacchini; he thought it was not necessary to publish so extensively, as the cost would be excessive. He thought that the observations should be preserved in manuscript.

MM. WILD and HANN urged the importance of the Committee expressing an opinion as to the utility of such publications, so that the Directors might make use of it in special circumstances in order to obtain funds from various sources.

MR. SCOTT stated that the Meteorological Office had published the curves of their self-registering instruments for seven stations for the 12 years 1869–80. and, in addition, the hourly observations for 1874–1883. From the last date the number of these stations had been reduced, and at present the observations of four stations only were published *in extenso*.

M. Neumayer was of opinion that the question of the utility of the publication of hourly observations could not be decided without taking into consideration the physical conditions of the country.

The following resolution was adopted :—

"*The Committee finds, after the discussion of this question, that it is desirable to recommend the publication of hourly observations* in extenso *for a limited number of stations only in each country chosen with reference to the physical conditions of the country.*"

The discussion was opened on Question 21 of the Programme :— "The publication of the sums of the deviations of temperature."

M. Buys Ballot desired to draw the attention of meteorologists to the importance of publishing these data, and also the sums of deviations of atmospheric pressure in any discussions of climates. (Appendix IV.)

In adopting the proposal of M. Buys Ballot, the Committee expressed the opinion that in researches on the variability of climates, it was desirable to take into consideration the sums of the deviations of the mean values of temperature.

The discussion was opened on Question 22 of the Programme :— "The comparison of spirit thermometers with the air-thermometer below 0° C."

M. Wild called the attention of the Committee to the importance of this comparison, especially for instruments intended for the use of stations or of travellers in distant or Polar regions. He proposed, therefore, that the Committee should communicate with the International Committee of Weights and Measures, and request them to undertake the comparison of standard spirit thermometers with the air-thermometer from 0° to − 70° C.

M. Wild's proposal was adopted. (Appendix V.)

The discussion was opened on Question 6 of the Programme :— "The definition of days of rainfall."

M. Hann, after having pointed out to the Committee how desirable it would be to give more detailed information respecting the daily fall of rain, proposed the following resolution :—

"*In order to be able to compare the number of days of rain, the Committee recommends the publication of the number of days of rain, snow, &c., when the fall amounts to one millimetre* (·04 *inch*), *or more, in the summaries of results, in addition to the system already in use.*"

This proposal was adopted.

The meeting rose at 4h. p.m.

(Signed) H. Wild.

Protocol of the Second Meeting, Tuesday, 4th September, at 10h. 20m. a.m.

Present: MM. Wild (President), Buys Ballot, Capello, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

MM. Billwiller and Gould were present by invitation.

The discussion was opened on Question 13 of the Programme :— "The present position of the Committee."

After an exhaustive discussion, in which all the members took part, the following resolution was framed :—

"*Considering that the convening of an International Congress with the character of the preceding Congresses of Vienna and Rome presents great difficulties, the Committee feels that its mission is ended, and that it ought to dissolve itself.*

"*Nevertheless, in order to continue the relations between the different meteorological systems, which have been so fruitful for some years past, the Committee nominates Executive Officers, who will be charged with taking steps for convening at a suitable time an international meeting of the representatives of the various meteorological services.*"

The resolution was adopted.

M. Hann proposed the following resolution :—

"*The Committee request its Executive Officers, viz. : M. Wild (President) and Mr. Scott (Secretary) to accept the mission indicated in the last resolution.*"

The resolution was adopted.

M. Wild expressed to the Committee, in his own name and in that of Mr. Scott, his acknowledgments for the confidence of the Committee in them, which it had kindly intimated by this choice.

The President announced that the Programme was exhausted.

M. Billwiller reported that the Swiss Federal Council had requested him to welcome the International Meteorological Committee in its name. He said : —

"The Committee, in choosing Swiss territory for the second time for its meeting, does a great honour to our country. In order to show the sympathy of the Federal Council with the international labours in the domain of meteorology, it offers to the Committee a banquet, to which the members of the Swiss Meteorological Commission are also invited. The Federal Council expresses its regret at being unfortunately prevented from being represented thereat by one of its Members."

The President requested M. Billwiller to convey to the Federal Council the expression of the sincere thanks of the

Committee for the kind and cordial welcome which it had kindly given them again on this occasion.

The meeting closed at noon.

The meeting was opened at the Hotel Bellevue at 2h. 30m. p.m.

All the members were present, viz. :—

MM. Wild (President), Buys Ballot, de Brito-Capello, Hann, Mascart, Mohn, Neumayer, Tacchini, and Scott (Secretary).

M. Buys Ballot, as Senior Member of the Committee, expressed the cordial thanks of that body to the Executive Officers for the zeal they had shown in the operations of the Committee during the period of nine years.

On the invitation of M. Mascart, the President was requested to append to the protocol of the present meeting a report upon the work of the Committee since its appointment at Rome. (Appendix VI.)

The protocols of the two previous meetings were read and confirmed.

The President declared the meeting closed.

(Signed) H. Wild.

APPENDIX I.

International Meteorological Committee Meeting at Zürich, 1888.

Programme.

1. Should the reduction of barometric readings to the gravity of latitude 45° be generally introduced? (Report of the Paris Meeting, p. 5.)

2. Is it desirable in meteorology to reckon the hours of the day from 0h. to 23h., in accordance with the resolutions of the International Conference at Washington? (Paris Report, p. 6.)

3. The method of reduction of barometric readings to the level of the sea for synoptic charts. (Paris Report, p. 9.)

4. The determination of a certain zenithal zone for the estimation of the amount of cloud. (Paris Report, p. 9.)

5. The uniform designation of halos and coronæ. (Paris Report, p. 10.)

6. The definition of days of rain and snow. (Paris Report, p. 10.)

7. Should not the general adoption of a uniform height above the ground for rain-gauges be recommended? (Paris Report, p. 11.)

8. What progress has been made recently in the more exact measurement of snow? (Paris Report, p. 12.)

9. The general adoption of a standard anemometer for the determination of the velocity of the wind. (Paris Report, p. 12.)

10. The general adoption of a uniform height above the ground for anemometers. (Paris Report, p. 12.)

The Royal Meteorological Society (London) again asks for a reply to these two questions.

11. Cannot the same time be adopted throughout Europe for all telegraphic reports, whether it be local time or simultaneous time? We should thus avoid the existing differences of from 1–3 hours between neighbouring stations on either side of frontiers. (Paris Report, p. 14.)

12. The Committee desires to express its earnest desire of seeing the observations of a certain number of stations, even a limited number, in North and South America, published in accordance with the international plan. (Paris Report, p. 16.)

Fresh Questions proposed.

13. The substitution of a meeting of the directors of the principal meteorological systems for International Meteorological Congresses, and for the International Meteorological Committee.

The Committee resigns its office with an explanation of the reasons for so doing, and with a final report of its operations.

14. The classification and nomenclature of clouds according to MM. Hildebrandsson and Abercromby. (M. Hann.)

15. Should not conditions be recommended to be laid down for the publication of observations from distant stations?

16. On the possibility of adding the direction and velocity of cirrus clouds, and the time of the barometric minimum, in meteorological telegrams. (M. Capello.)

17. Meteorological warnings from semaphores to ships passing near the coasts. (M. Capello.)

18. Would it not be better to adopt 9h. p.m. instead of 7h. a.m. for the measurement of rainfall? (M. Wild.)

19. Of what present use is the publication *in extenso* of the hourly observations of the different meteorological observatories? (M. Wild.)

20. Definition of Silver Thaw (givre, Rauh-frost), and of Glazed-Frost (verglas, Glatteis). (M. Wild.)

21. Discussion of the different methods suitable for representing the variability of climate, especially of temperature. (M. Buys Ballot.)

22. Comparison of standard spirit thermometers with the air-thermometer, from 0° to −70° C. (M. Wild.)

(Signed) H. Wild, President,
R. H. Scott, Secretary,
International Meteorological Committee.

APPENDIX II.

Transmission of the Time of the Barometric Minimum, and the Direction and Velocity of Cirrus Clouds in Meteorological Telegrams.

Meteorological telegrams, being intended principally for the prediction of weather, should contain, among all the meteorological elements, those which can throw most light upon the study of the problem.

From the present method of framing these reports, we cannot tell whether the barometer has continuously risen or fallen, between the two observations, viz., those of the morning and of the previous evening, or whether a minimum has occurred between them.

The knowledge of the time of the barometric minimum and the value of this reading at a small number of neighbouring stations is of great importance for the study of weather prediction.

If we know the minimum reading, and the time of its occurrence, we can trace the isobars with greater certainty, we can more easily determine the track of the centre of the depressions, and lastly, we can better judge whether the fall of the barometer will soon cease, or whether, on the contrary, the mercury will continue to fall.

By selecting in each country two or more stations, where the barometric minimum and its time of occurrence are given, the telegrams from these stations would be increased by a group of five figures: three for the value of the minimum, and two for the time, reckoned from midnight to midnight (0–24) civil time.

A minimum (reduced to zero and to sea-level) of 746 · 4 mm. (29 · 39 inches) at 10h. p.m. (22) would be transmitted as 46422 (93922).

If the barometer has fallen continuously since the previous evening, the minimum will be the actual reading of the barometer at the time of the morning observation, that is to say, this reading will be repeated in the same telegram.

If, on the contrary, the barometer has been rising since the evening, the minimum value and the time will correspond to the reading of the evening observation.

The Direction and Velocity of Cirrus Clouds.

All meteorologists will agree that the indication of the direction and velocity of cirrus clouds in meteorological telegrams is of great value for the study of weather prediction.

The Committee, at the Paris Meeting in 1885, recommended the observation of the movement of clouds, especially of cirrus, and the introduction of these data for a few stations at least, in meteorological telegrams.

For a complete study of the movements of the upper clouds, no doubt the "Provisional instructions in making observations of the upper clouds" are the best to be employed in telegrams, but there is the one drawback, that the telegrams contain three groups of five figures.

I think we can introduce the data which are absolutely necessary in the telegrams by adding only one group. This group would consist of two figures for denoting the point of radiation, two for the direction, and one for the velocity of the cirrus or cirro-cumulus.

Thus, 20243 would denote cirrus or cirro-cumulus visible in the S.W., moving from the W., with velocity 3.

If the point of radiation cannot be determined, we should put xx (or 99) for the two first figures, and the group would stand as 99243.

If there is no cirrus the group would be 99999.

(Signed) J. Capello.

Observatory, Lisbon, 20th July 1888.

APPENDIX III.

Meteorological Information to Ships passing within sight of Semaphores.

Since the 1st August 1888 a free service of notices to ships passing within sight of the semaphores of the coast of Portugal has been established.

These notices relate to the state of the weather at 7h. a.m. in neighbouring localities, to the north and to the south; in the north they refer to the Bay of Biscay, and in the south, to the Strait of Gibraltar and the Island of Madeira.

This service was long since suggested by our illustrious colleague, M. Buys Ballot, and recently by M. van Citters, who has taken steps in the matter in Spain and Portugal.

There being no simple international signals to represent the state of the weather in the localities in question, we have employed, provisionally, the Commercial Code of signals, which is known to all seamen.

From the meteorological reports received in the morning from France, Spain, and the Island of Madeira, the Observatory of the Infante D. Luiz is enabled to send to the semaphores very concise telegrams of the state of the weather to the north and south of our coast. These are the telegrams or notices that are transmitted free to the ships wishing to know the state of the weather at any of these three localities.

The semaphores selected are Sagres (Cape St. Vincent), Cape Espichel, Oitavos (entrance of the Tagus), Cape Corvoeiro, and Luz (Oporto).

For the two southern localities (Strait of Gibraltar and island of Madeira) the warnings are usually sent from the observatory at noon; for the Bay of Biscay they are sent later, generally at 2h. p.m.

Before these hours the warnings refer to the evening before, and this plan holds good for the afternoon when the telegrams from the observatory have not arrived at the semaphores.

In every case the date must always precede the warnings.

Generally, the state of the weather is indicated by the direction and force of the wind; the former by the eight principal points, N., N.E., E., S., &c., and the force by the words calm, light, moderate, fresh, strong, and violent.

Notice of this new gratuitous service of the semaphores has been given to seamen, together with all the details above referred to.

I think it would be quite possible to improve the service and to establish a system for giving information on all the western coasts of Europe; this would render a real service to navigation.

We might suppose, for instance, the western coasts of Europe to be divided into districts numbered from north to south.

Each country would choose a certain number of semaphores which would have to issue notices of the weather in the neighbouring localities.

The same signals should be used for all coasts, and they should be of the simplest kind; for instance, one flag to indicate the number of the district,

another to denote the direction of the wind, and a third, or a triangle, to show the force.

If the state of the weather referred to the previous evening, a ball might be added.

In this way passing ships would be warned of the state of the weather in the districts towards which they were proceeding, without asking for the information and without delay.

(Signed) J. Capello.

Lisbon Observatory, 20th July 1888.

APPENDIX IV.

On a Method of representing the Variability of the Weather, especially by giving the Average Value of the Deviations (écarts) irrespective of Sign.—By Prof. C. H. D. Buys Ballot.

The variability of temperature and of barometrical pressure at a given station may be represented in various ways.

A. The mean daily range as given by the mean hourly observations (Met. Jaarboek, 1868–70). The mean excess of the maximum above the minimum readings is given for three stations in the Netherlands in each volume (Resumé in the Versl. und Meded. der Kon. Akad. of Amsterdam, Series ii., Tom. ix., p. 183, Table iv.)

B. In the Jaarboek, 1864 and 1865, I have given for each month the alternating maximum and minimum readings, with the dates on which they occurred, the mean of the subsequent differences being added separately.

From these the mean variation from each day to the following may be found, with considerable accuracy, by dividing by the number of days in each month. See the same Verslagen, quoted above.

Professor Hann has given this mean variation for 90 places, calculated in absolutely exact numbers, in his classical inquiry (Untersuchungen über die Veränderlichkeit der Tages-temperatur. Sitzungsber. der K. Akad. der Wiss. Wien, Vol. LXXI., 1875. Abstract in Oest. Met. Zeitschrift, Vol. XI., p. 336.)

Dr. Hann gave also tables showing the number of times that a change of 1°, 2°, &c. occurred, and what is the probability of such an occurrence. MM. Köppen, Hegyfoky, and Oscar Doering have made similar calculations, in Vols. XV. and XVIII. of the Oest. Met. Zeitschrift, and Vol. V., p. 281, of the Met. Zeitschrift respectively. Lately Dr. Wahlèn, in his valuable work (Wahre Tages-mittel und tägliche Variation der Temperatur an 18 Stationen des russischen Reiches. St. Petersburg, 1886. Dritter Suppl.-band zum Repertorium für Met.), has given similar calculations.

I myself, in the Vers. and Med., *l.c.*, contented myself with giving in Table V. the mean variability for three stations and for 30 years, showing that this variability from day to day, as well as the daily range, is greater for Maestricht, and less for the Helder on the sea coast, than it is for Utrecht.

C. Dove has defined variability of temperature to be the mean of the monthly departures from the values for a series of years, or rather from well-determined normal values. This is a very valuable method, which I myself have adopted, but it ought to be completed by D and E.

D. A fourth method, which I venture to recommend, consists in giving for each month the sums of the departures (écarts) from the normal value, or, what is perhaps better, these sums divided by the number of days in the month.

Beginning with the year 1863, I have given these sums for groups of stations, and separately for the stations where the sums were least and greatest respectively. The tables show clearly that as for the temperature the sums are least for islands, almost irrespective of their latitude, and as for the barometer they increase with the latitude.

E. It is very interesting to show in a table for how long and at what figure a departure may continue of the same sign. This I have shown in each Jaarboek since 1849 for Utrecht, occasionally for selected stations in Europe, and in the Jaarboek for 1879 II. for a great number of places in the northern hemisphere.

From these tables D and E, partially only in manuscript, I have extracted the maximum sums, those above 100° C. (or 100 mm.) up to 293° C. for the temperature departures at Helder, Utrecht, and Maestricht, from 1852 to 1874, and printed them in the Versl. und Med., Series II., Tom. IX., Table VII., and for the following years ,here and there, in the Jaarboeken from 1876. For Utrecht these tables give all the sums, both small and great, for temperature and barometer from each Jaarboek.

The accuracy of these sums depends to a certain extent on the accuracy of our knowledge of the normal values.

If an error of, say, 1° C. or 1 mm., be made in estimating these normal values, it will be necessary to subtract or add as many degrees or millimetres as there were days on which the departures lasted with the same sign; and what is still more awkward, such a series may seem to continue longer or shorter when the sign itself is altered by this uncertainty. Nevertheless, this source of error does not exert so much influence as might be supposed, and moreover the sums are interesting for other inquiries.

I shall not dwell longer on these different methods, each of which has a different meaning, but shall conclude with a few words in recommendation of the method D, combined with C.

The sum of the departures (Σ) for a month, or their average values $\sqrt{S}$ for one day in such a month, are not so much dependent on an accurate knowledge of the normal value, especially if the departures have different signs in nearly equal proportions, the positive (p) increasing, while the negative (n) decrease, and *vice versâ*, by the same amount. It is generally the case that only very few figures are changed in their sign by such an error. For instance, Paris, March 1879, the sum is 226 mm. It would have been the same if the normal had been 1 mm. higher, and if it had been 1 mm. lower, which would be quite impossible, the result would have been 288. Even Posen, April 1879, for which the result is 236 mm., the normal being 754·9, it would have been 265 if the normal had been accepted as 755·9, and only 237 if the normal had been 753·9. This is the most extreme case I could find.

It is, however, only for a very few stations, for mountain stations, and for such as are very distant from those for which the normals are well determined, that an error of 1° or of 1 mm. is possible, and this error will be diminished or reduced to zero after some years of careful examination of the normals. Accordingly this method will become as accurate as method C.

In recommendation of this method I may say that these sums are obtained without any trouble of calculation, which is not the case if the variability from day to day is calculated. Every one who calculates departures (and this practice is coming into general use, and is very desirable for other purposes), is compelled to use the sum of them as a check on his work. He obtains separately the sum Σp, and the mean value P of positive departures by adding the sum Σn of the negative departures, and their mean value N, by subtracting the deviation of the month, and of course when both these results are obtained you can get the sum of each.

For instance, if we find for a place the mean sum for a month S, and the mean departure D, we know that $\frac{1}{2}(S+D)$ and $\frac{1}{2}(S-D)$ multiplied by the number of the days of the month represent the sums Σp and Σn of all the positive and negative departures respectively.

If S is nearly equal to D, the departures have nearly all the same sign; if D, on the contrary, is very small, then the sums of both kinds are very nearly equal. I say, therefore, that this method should be combined with method C.

Let, for instance, as in May 1879, for Aarau, the departure from the temperature for each day, though great, have been not greatly different, D on the average $-4°\cdot15$ then the variation V will be relatively small $1°\cdot71$, while $S = D$, $\Sigma = 31\,D$.

When 15 of the departures are almost of the same amplitude and positive, and the 15 following negative, then just as when they change frequently in

sign, being alternately + and —, the departure in both cases will be nearly 0, while in the first case, from method C, V will be small, in the second great.

Christiansund, May 1879, gives S = 2°·58 D, = −0°·09, V = 2°·40.
Klagenfurt, April „ S = 2°·35 D, = +0°·25, V = 1°·33.

S, D, and V appear to be far from being proportional to each other, and therefore they should, each of them, be represented, in order to indicate the climate of the place, and the character of the month.

In sanitary respects, the second case is more dangerous than the first, while in both cases the meteorological disturbance is very slight.

Between the two cases, method E decides by representing the greatest sum of departures of the same sign in continuation.

On the whole, however, in a long series of years all these different cases will be represented, and both methods, as well as the third D, will give a similar result. I do not dispute the value of method B, and in fact think highly of it, but I think that method D is of equal or greater value than B, especially if it is combined with C and E. The three latter being much more easily obtained than B, and obtained by one and the same calculation, the numbers of D and E being obtained by a simple addition of the departures, but serving as a check on the calculation.

(Signed) Buys Ballot.

APPENDIX V.

International Meteorological Committee,
Zurich, 6th September 1888,

Sir,

In the name of the International Meteorological Committee, I have the honour to convey to you the following request which was framed and adopted at its meeting of the 3rd September, at Zurich :—

The International Committee of Weights and Measures is requested to be good enough to make the necessary arrangements at the International Office at Breteuil for the comparison of the normal spirit thermometers of the various countries with the hydrogen thermometer at temperatures below 0°, ranging from 0° to about −70° C. This measure will make it possible to adopt generally in meteorology a scale of temperature in accordance with the hydrogen thermometer established in 1887 by the International Committee of Weights and Measures, and to obtain in this way comparable data in Meteorology for low temperatures.

Will you kindly submit this request to the Committee at its next meeting, and let me know in due course its decision thereon.

Meanwhile, I am, &c.
(Signed) H. Wild,
President of the International Meteorological Committee.

International Committee of Weights and Measures,
Neuchatel, 27th December 1888.

Sir and much honoured Colleague,

I have the honour to inform you that the request of the International Meteorological Committee that you have communicated to General Ibañez, with the view of having the normal spirit thermometers of the central Meteorological offices of the different countries compared with the hydrogen thermometer at the International Office of Weights and Measures, for temperatures ranging from below zero to about −70°, has been communicated to the International Committee of Weights and Measures at its first meeting on the 29th September 1888.

In accordance with a proposal made by the Commission of prototypes and investigations, the International Committee has unanimously decided at its second meeting, on the 3rd October, to comply with your request, on the condition that it is well understood that these experiments do not imply any contradiction with the previous decision of the Committee to devote for the present all the resources of the International Office to the completion of the prototypes. It is understood that you would begin by first ordering the spirit thermometers and by organising the necessary arrangements.

It would perhaps be well that you should send shortly one of your normal spirit thermometers so that we may take note at Breteuil of the dimensions and necessary constructions in ordering the apparatus.

I am, &c.

(Signed) Ad. Hirsch,

Secretary of the International Committee of Weights and Measures.

APPENDIX VI.

Report on the Work of the International Meteorological Committee, instituted by the Congress of Rome in 1879.

The International Congress of Meteorologists at Rome adopted the following resolutions at its third meeting on the 19th April 1879 :—

I. "The second Meteorological Congress assembled at Rome institutes an International Meteorological Committee, which is charged with everything that concerns international relations until the meeting of the next Congress."

II. "The Committee is composed of nine members, elected by ballot under the restriction that two delegates of the same country cannot hold seats on it at the same time."

III. "In case of vacancy by the resignation or by the death of one of its members, the Committee may complete itself by the co-option of a new member, having regard to the restriction above indicated."

IV. "The Committee elects its own executive officers and distributes its labours among the different members."

V. "The Committee is charged with seeing that the decisions of the Congress are carried out; with the convening of future Congresses; with the preparation of the questions which should be submitted to this Congress; with the keeping the delegates to the present Congress informed of its proceedings and of its decisions; and lastly, with the presentation to the next Congress at the expiration of its functions of a report embracing the whole of the period."

At its fourth meeting, on the 21st April 1879, the Congress appointed the members of the International Meteorological Committee, viz. :—

Mill. Buys-Ballot, Director of the Meteorological Institute of the Netherlands, at Utrecht.

Cantoni, Director of the Central Meteorological Office, at Rome.

De Brito Capello, Directory of the Observatory of the Infante D. Luiz, at Lisbon.

Hann, Director of the Central Meteorological Institute at Vienna.

Mascart, Director of the Central Meteorological Office at Paris.

Mohn, Director of the Meteorological Institute of Norway, at Christiana.

Neumayer, Director of the Deutsche Seewarte, at Hamburg.

Scott, Secretary of the Meteorological Council, at London.

Wild, Director of the Central Physical Observatory, at St. Petersburgh.

This Committee constituted itself at a first meeting at Rome on the 22nd April 1879, electing :—

M. Wild, President.

Mr. Scott, Secretary.

Immediately after the close of the Congress of Rome, the Executive Officers of the Committee, with the consent of the other members of the Com-

mittee, took measures to carry out the decisions of the Congress, and afterwards, in the month of August 1880, convened a first meeting of the Committee at Berne, for the purpose of discussing and deciding such questions as could not be dealt with by correspondence. Later on, in August 1882, a second meeting of the Committee was held at Copenhagen, then a third at Paris, in September 1885, and, finally, a fourth and last at Zurich, in September 1888.

At this final meeting, the Committee unanimously adopted the following resolution. (See p. 7):—

"The International Meteorological Committee, considering that the convening of an International Congress, with the character of the preceding Congresses of Vienna and Rome, presents great difficulties, feels that its mission is ended, and that it ought to dissolve itself."

"Nevertheless, in order to continue the relations between the different meteorological systems which have been so fruitful for some years past, the Committee nominates Executive Officers, who will be charged with taking steps for convening at a suitable time an international meeting of the representatives of the various meteorological services."

Consequently, the actual Executive Officers, viz.: M. Wild, President, and Mr. Scott, Secretary, were charged with the duties indicated in the preceding resolution, and the President was requested to append to the Report of the Meeting at Zürich a report on the operations of the Committee from its appointment at Rome until its dissolution at Zürich.

As detailed notices of the operations of the International Meteorological Committee have been already published in the reports of the four meetings specified, which appeared on each occasion in French, German, and English,* I have only to classify the work of the Committee systematically according to these reports, in order to form a general Report.

The International Meteorological Committee have only had a single modification in their constitution since their election at Rome. M. Cantoni having resigned his seat on the Committee, by his letter on the 3rd July 1882, was replaced, in accordance with his request, by M. Tacchini, who had been the Director of the Central Meteorological Office of Rome since 1879, and who was unanimously elected a member of the Committee at the Meeting at Copenhagen.

At the same the question was discussed whether the number of the members of the Committee should not be augmented by the addition of some gentlemen representing other important meteorological services. But the majority of the members being of opinion that the second resolution of the Congress of Rome, respecting the formation of the Committee, put a formal obstacle to this augmentation, it was decided that a change in this respect could only be made by a future Congress.

The liberality of the Italian Government greatly assisted the Committee in its first task of preparing the *Rapport des travaux du Congrès de Rome*, and of publishing it in three languages:—English, French, and German. Aided by the assistants of the Central Meteorological Office of Rome, the Committee prepared this Report first in French, and this was published and distributed at the expense of the Italian Government. Mr. Scott afterwards published a translation in English, and M. Neumayer one in German, the publication in these two languages being made at the expense of the respective Governments.

Two other resolutions of the Congress of Rome also called for the earnest attention of the Committee. After having consulted M. Neumayer, Director of the Deutsche Seewarte, at Hamburg, the Executive Officers of the Committee, in pursuance of the decisions of the Congress, invited the different countries, by circular of the 9th August, 1879, to send delegates to a special Conference, to be held at Hamburg, on the 1st October 1879, for the purpose

* The English edition has always been published by Mr. Scott under the authority and at the expense of the Meteorological Council in London, the French edition, by M. Mascart, at the expense of the Central Meteorological Office of France, and the German edition, at the expense of the German Government, by M. Neumayer.

of preparing a definite plan for the simultaneous and international exploration of the Polar regions, in accordance with the scheme of M. Weyprecht.

It is known that this Conference resulted in the formation of an International Polar Committee, which worked more or less independently of the International Meteorological Committee and brought this undertaking to a successful issue. The proceedings of this Committee are published in the *Bulletin of the International Polar Committee*, edited by M. Wild, and published at the expense of the Imperial Academy of Sciences of St. Petersburg.

By a circular dated the 8th April 1880, the Executive Officers of the Committee, in co-operation with Dr. Lorenz von Liburnau, chief of the service of Forest Meteorology in Austria, invited the different countries, through the medium of their meteorological representatives, to send delegates to an International Conference for Agriculture and Forest Meteorology which met at Vienna on the 6th September 1880. A programme of the questions to be discussed by this Conference was annexed to the circular. By the month of December 1880, the President of this Conference, M. Lorenz von Liburnau, had distributed the printed report of the discussions and resolutions of the Conference, together with a lithographed copy of the protocols of the meetings.

On the proposal of M. Wild, the Committee at the commencement of 1880 resolved to endeavour to bring about the comparison of the standard instruments of the central offices, viz., barometers, thermometers, and anemometers, recommended by the Congress of Rome. A circular of the Committee dated 21st April, containing details as to the manner of carrying out this comparison, was accordingly addressed to the meteorological institutes and observatories of the different countries, asking whether they would take part in this undertaking and contribute towards the expense. Unfortunately, instead of 30 institutes required to contribute towards the expense of carrying out the work, only 20 expressed their willingness to share in it. The Committee had, therefore, to abandon the scheme, and at its meeting at Berne recommended that in the meantime an endeavour should be made to substitute for this general comparison a comparison of the standard instruments of neighbouring countries. In fact, several partial comparisons have been subsequently made, and it has been shown that the steps taken by the Committee have at least had favourable results, as, in consequence of these comparisons, several institutions have procured standard barometers of improved construction.

The Congress of Rome invited the Directors of the different meteorological systems to publish catalogues of the published and unpublished observations existing in their countries, and expressed the desire that a general catalogue of meteorological works and papers should be prepared, based upon the catalogues of this kind, which already exist in several countries. The Committee took into consideration the realisation of these desiderata of the Congress, with the zealous co-operation of Dr. Hellmann of Berlin. The discussions upon this subject at the meeting at Berne not having led to any definite result, the Committee requested MM. Scott and Hellmann to again study the means of carrying out these desiderata, and to report upon them. The report presented upon this question by those delegates at the meeting at Copenhagen has shown, at least for the present, the impossibility of publishing a general catalogue, and the Committee was obliged to content itself by again requesting the Directors of the different meteorological services to publish in the meanwhile special catalogues for their respective countries, referring both to published and unpublished observations and to meteorological works and papers.

The Committee has been more fortunate in its efforts to carry out the wish of the Congress for the preparation of a collection of auxiliary meteorological tables which might be used as International Tables in the different countries. At the meeting in Berne, the Committee appointed a Sub-Committee, consisting of MM. Mascart and Wild, to consider a plan upon this subject, and to prepare a report for a future meeting. This Sub-Committee presented a detailed plan at the next meeting, at Copenhagen, which was distributed for consideration. At the meeting at Paris, the Committee again requested

the same Sub-Committee to make definite arrangements for the calculation and publication of the tables, in accordance with the various suggestions made.

The Sub-Committee having submitted a detailed plan to the members of the Committee and other meteorologists, it was approved with some slight modifications, M. Mascart was entrusted with the superintendence of the calculations, and M. Gauthier-Villars, of Paris, with the printing of the tables. At the meeting at Zürich it was reported that the calculation of the tables was finished, and that the printing, being considerably advanced, might be completed in the course of the year 1889.

The Congress of Rome wished to show to what degree the methods of observation and publication of observations in different countries were in conformity with the decisions of the Congresses of Vienna and Rome. Consequently the Executive Officers of the Committee requested by circular dated 30th October 1880, information upon this question from the directors of the different meteorological systems. The replies to this circular are printed in Appendix VIII. of the Report of the meeting at Berne, and contain information referring to Germany (Seewarte, Prussia, Baden, Saxony, Württemberg), Austria and Hungary, Denmark, Spain, France, Holland, British Isles, Italy, Norway, Portugal, Russia, and Switzerland. On some points, information will also be found from Belgium,* Greece, Japan, Roumania, and Sao Paolo and Bogotá, in South America.

In accordance with a resolution of the meeting of the Committee at Copenhagen, their Executive Officers sent a circular on the 31st December, 1882, to the Directors of the Central Meteorological Services, asking for complete information upon the organisation of the meteorological service in their countries. The Committee received replies to this circular from M. Neumayer for Germany generally, and specially for the Deutsche Seewarte at Hamburg; from M. Hellmann for Prussia; from Dr. von Bezold for Bavaria; from M. Schreiber for Saxony; from M. Schoder for Württemberg, and lastly, for the Grand Duchy of Baden, and the Imperial Provinces of Alsace-Lorraine; from Mr. Scott for England and the English Colonies, and specially for the Meteorological Office and the Royal Meteorological Society at London; from Mr. Christie for the Royal Observatory at Greenwich; from Mr. Whipple for the Observatory at Kew; from Mr. Carpmael for Canada; from Mr. W. Ellerton Fry for the Cape of Good Hope; from Mr. Stoddart for the Island of Ceylon; from Sir James Hector for New Zealand (for Victoria, New South Wales, and South Australia some details will be found in the Report of the Second Conference held at Melbourne in April 1881, Appendix V. of the Copenhagen Report); from M. Hann for Austria; from M. Schenzl for Hungary, and from M. Müller for the Hydrographic Office of Pola; from M. Houzeau for Belgium; from M. Hoffmeyer for Denmark; from Professor Nipher for the Meteorological Service of Missouri (United States); from M. Mascart for France; from M. Tacchini for Italy and from M. Gaspari for the Observatory of Naples; from M. Mohn for Norway; from M. Buys Ballot for the Netherlands; from M. de Brito Capello from Portugal; from M. Wild for Russia and from M. Nordenskiold for Finland; from M. Rubenson for Sweden; from M. Malmberg for the Nautical Meteorological Office at Stockholm; from M. Hildebrandsson for the Meteorological Observatory at Upsala; and from M. Billwiller for Switzerland.

The question of the observation of the movements of clouds, and especially of cirrus, also recommended to the care of the Committee by the Congress, has been several times discussed by the Committee. At the meeting at Paris in 1885, a Sub-Committee appointed at the Copenhagen meeting, consisting of MM. de Brito Capello, Hildebrandsson, and W. Clement Ley made a detailed report, with instructions for the observation of the motion of clouds, which has been published in the protocols of that meeting.

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* Complete information for Belgium are contained in Appendix XII. of the Report of the meeting at Copenhagen.

The Committee recommended the general adoption of these instructions for the motion of clouds, and the introduction of those details, at least for some stations, in meteorological telegrams.

The Congress of Rome deliberated at some length upon the extension of regular meteorological observations to countries and regions where they were then wanting, and it expressed the desire that hourly observations might be made in inter-tropical countries. During the ten years since elapsed, the Committee have endeavoured to contribute towards the accomplishment of this desire, and has been able to report progress in this direction. A meteorological service has been established at Japan, where it works very well; in the Corea we have for some years possessed stations at several ports; in China a series of meteorological stations along the sea coast has been established by the Chinese Maritime Customs; a series of meteorological stations is about to be established at telegraph stations in Brazil, under the direction of Baron de Capanema, with self-recording instruments in some places; in the Argentine Republic a meteorological service has been established in the province of Córdoba, under the direction of M. Doering; and meteorological stations have also been established in the Portuguese Colonies of the Congo, as well as in the French possessions of the Congo; and, lastly, by Germany in New Guinea, the Cameroons, and the Herero Land. In Roumania, a meteorological institute has been established at Bucharest, under the direction of Professor Hepites, &c.

Since the Congress of Rome, and in accordance with the desire expressed by it, the mountain meteorological stations already existing have been developed, and several recently organised, viz.:—

		Height above Sea.
		Feet.
Germany	Brocken	3,747
	Schneekoppe	5,246
	Wendelstein	6,027
Austria	Hoch Obir	6,706
	Sonnblick	10,154
	Schafberg	5,827
Switzerland	Säntis	8,094
France	Puy de Dome (founded in 1876)	4,823
	Mont Ventoux	6,234
	Pic du Midi	9,380
Portugal	Serra da Estrella	4,728
Italy	Mount Vesuvius	4,265
	Monte Cimone	7,094
	Mount Etna	9,679
Scotland	Ben Nevis	4,406
United States	Blue Hill	635
	Mount Washington	6,280
	Pike's Peak	14,154
	The last two stations have ceased their activity since 1888.	

On several occasions the Committee has been occupied with the important question of the establishment of an international telegraphic service for the North Atlantic, for the benefit of weather predictions, and it is especially to the late Captain Hoffmeyer that we are indebted for detailed plans relating to this question. Unfortunately the great expense has prevented the realisation of these schemes.

As is shown by the protocols and reports of the various meetings of the Committee, the latter has discussed, either by correspondence or at its meetings, a number of other questions of general interest; these, however, have not found a definite solution, because the question did not appear to be sufficiently studied at present, or because the Committee did not consider themselves authorised to make decisions, and wished to reserve them for a future Congress.

The labours of the two International Meteorological Congresses which have hitherto been held, as well as those of their Committees, have doubtless greatly contributed to the advancement of meteorology, by uniting the efforts of the different countries in certain directions, by facilitating the researches of meteorologists by means of the unification of the methods of observation and of the publication of observations in different countries, and by notifying the most important questions to be settled by fresh investigations.

Much still remains to be done in these different directions. Let us hope that the Conferences of the heads of all the meteorological services which are in future to replace the Congresses and their Committees, will be able still better to realise the agreement between different countries, so desirable for meteorology, which is a science truly international.

(Signed) H. Wild, President.

St. Petersburg, 13th December 1888.

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